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QUEENSLAND.

TIARO DISTRICT.

THE COAL MEASURES, NEARDIE ANTIMONY MINE, AND TEEBAR AND CULGOA COPPER LODES.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

The country described in this report extends from Mungar southward to Curra; and from the coast westward to the dividing range between the Wide Bay and Burnett districts; it comprises an area of nearly 900 square miles.

This area is drained by the Mary River, which runs in a northerly direction to Maryborough, and thence in a north-easterly direction into the Great Sandy Straits. The principal creeks are the Tinana and Munna; the former of which drains that portion of the country to the east, and the latter that to the west of the Mary River.

The greater part of this country is composed of rocks belonging to the Burrum coal measure series. It is a continuation of the Burrum Coal Field, a report on which has already been presented by me.*

To the east of Tinana Creek is a flat wallum country, in which very few sections of the rocks are visible; to the west of that creek the country becomes more and more ridgy and broken as the dividing range is approached.

On tracing the coal measures westward from the Mary River, a large tract of sandy country is passed over, derived from the disintegration of a coarse freestone. West of this, at Glenbar and Gigoomgan, there is a series of rocks consisting chiefly of slates and limestone. At Gigoomgan a great mass of bluish-grey limestone can be traced for a distance of at least fourteen miles, running in a north-north-westerly direction. Near the head station I found a few fossils, but they are very scarce, and not well preserved; I was able to identify some of them as identical with those of the Gympie beds; they were—*Aviculopecten squamuliferus*, Morris. *Spirifera sp.*, *Stenopora sp.*, and *Encrinital stems.*

The actual junction of these beds with the coal measures is concealed by the sandy country alluded to above.

At the southern boundary of the coal measures the relation of these beds to one another is better seen on the Maryborough and Gympie Railway, about two miles south of the Curra station.

There is a hard porphyritic rock containing crystals of felspar, hornblende, and mica, in the cutting 51 miles from Maryborough. Laminated sandstone and shales, belonging to the Burrum beds, occur in a cutting 50½ miles from Maryborough. They dip north-west at 6 degrees, and overlie the porphyry, which here is more of the character of a white felsite. In the cutting at 51½ miles from Maryborough, white felsite occurs again, while ten chains further south the upper shales of the Gympie series come in, dipping east 40 degrees north at 45 degrees. A small "sheet" of felsite is seen in these shales about two chains further south, and a larger sheet of it about one and a-half miles south of that again.

The Gympie shales do not appear to have been baked or altered by this rock, and I am of opinion that the felsite is interbedded with the shales. But supposing the felsite to be intrusive in the shales, it was intruded before the Burrum beds were deposited, otherwise we should find it intruding those beds also, which is not the case. In either case, therefore, the unconformability of the Burrum and Gympie beds is manifest. (Plan 1.)

On the western boundary of the Burrum Coal Field, near Agnes Vale, the coal measures pass down into a series of altered rocks,† but there is there no unconformability as there is in the case of the Burrum and Gympie beds. Regarding the Burrum beds as the equivalent of the Triassic of Europe, or as lying between the Ipswich beds and the Bowen River beds, it is probable that the altered rocks at Agnes Vale occupy a position between the Burrum and Gympie beds, and are the equivalent of the European Permian.

Granite occurs in several places to the west of the Burrum beds, and of the slates and limestones of Gigoomgan. The granite near Tebar is a continuation of that at the Golden Fleece and Doongal, mentioned in my report on the Burrum Coal Feld. Granite also is met with at Culgoa, a few miles south of Gigoomgan.

A map of the district on the scale of two miles to an inch is attached to this report.

THE

* Report on the Burrum Coal Field by the Assistant Government Geologist. Brisbane: By authority, 1886.

† Burrum Report, p. 8.

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The Coal Measures.

The coal measures of the Tiaro district are much more disturbed by faults and intrusive rocks than in the Burrum and Howard district, north of Maryborough. The direction and amount of dip is seldom the same over any large area. In many places dykes and masses of intrusive rocks come up through and disturb the coal strata.

The Kannagan Range, near Gunalda, consists entirely of felsite porphyry. Mount Eaton, two miles to the west, is of fine-grained granite.

A mass of micaceous granite occurs on the western slope of Mount Bopple.

At Tiaro there is an intrusive mass of hornblende and felspar porphyry. (Plan 2.)

Near Aurora a large dyke of porphyritic rock forms a bar nearly across the Mary River. A similar rock occurs in a railway cutting north of Mungar.

As a general rule the angle of dip of the strata is very high.

The strata are very similar to those in the northern part of the field; they consist of conglomerates, sandstones, shales, and clays, with beds of coal.

The beds are full of plant remains, but with one exception, in a shaft on Bull's selection, No. 1357, where I found specimens of *Alethopteris Australis*, Morris, well preserved, they were not sufficiently distinct to be identified.

The seams of coal in places, are of sufficient thickness to be workable; and some of the coal is of very fair quality, considering that the samples taken for analysis were all from the outcrops of the seams.

The high angle of dip, and the faulted character of the measures, however, will, I believe, prevent the Tiaro district ever becoming a large coal-mining centre, although isolated patches may eventually be worked.

Following are the details of the sections of coal and rocks visible :—

Bull's Selections, near Gunalda.—In selection No. 1122 thin-bedded sandstones and black carbonaceous shales, dip north 50 degrees west at 14 degrees; this section is immediately south of the porphyry of Kannagan Range.

In selection No. 1357, about a mile and a-half to the north of the above, a shaft has been sunk for coal to a depth of 105 feet. The strata in the shaft consists of sandstones, hardened brown shales with nodules of iron pyrites, and black graphitic shales, dipping west 20 degrees south at a low angle towards the felsite of the Kannagan Range, which crops up a short distance from the shaft. A seam of anthracitic coal, from 18 to 20 inches in thickness, was cut at a depth of 41 feet. There would be but a small area of this coal to work, as it would be cut off by the intrusive rock of the Kannagan Range, which has baked the shales, and driven off the greater part of the hydrocarbon from the coal.

Analysis of the coal:—

	Per cent.	
Water	7·0	
Volatile hydrocarbons	8·6	Coke, 84·4 per cent. (non-caking)
Fixed carbon	68·4	Sp. gr. 1·5
Ash (grey)	16·0	
	100·0	

The coal is a bright steel-grey in colour.

In a gully a little to the north of this, sandstone dips west 20 degrees north at 12 degrees.

A small band of coal 3 inches thick, dips north 30 degrees west at 10 degrees, close to Mr. Bull's house, in selection 1105; overlying this is a thick bed of a fine and even-grained sandstone, suitable for building purposes.

Several sections of the coal-measure rocks are visible in the railway between Curra and Gunalda, and Gunalda and Kilkivan Junction. The angle of dip of the strata in these sections is high, and the direction of dip very variable, in short distances changing from south to north-north-east, and then again to south-east.

In a dam on Mr. W. C. Wilson's Sugar Plantation, three miles west of Kilkivan Junction, sandstone and shales, overlying an impure limestone, dip north-north-east at 25 degrees. A black carbonaceous shale is showing in the river just above Mr. Wilson's house.

Munna Creek, Selection 1767.—About two and a-half miles above the junction of Munna Creek with the River Mary, the following section is visible in the bank close to where the road crosses the creek. The dip of the strata is north 30 degrees east at 11 degrees :—

	Ft.	ins.
Shale	1	0
Coal (top seam)...	2	8
Black coaly shale	2	1
Coal, with a few thin bands (bottom seam)	3	0
Black and brown shales	3	3
Coal and shale mixed	3	0
	15	0

Analyses of the coal:—

	Top Seam. per cent.	Bottom Seam. per cent.
Water	6·0	5·0
Volatile hydrocarbons	22·6	29·0
Fixed carbon	49·9	48·5
Ash	21·5 (grey)	17 5 (reddish-grey)
	100·0 ...	100·0
Coke (non-caking)	71·2 per cent.	66 per cent.

The

The specific of the top coal is 1·43, that of the bottom coal is 1·53. They are both bright bituminous coals.

These seams are about five miles from the nearest point of the Maryborough and Gympie Railway, and are on the opposite (west) side of the River Mary from the railway, and about six and a-half miles from the Kilkivan Branch Railway.

On Tanyalba Creek, about a mile and a-half north of the coal on the Munna Creek, coal of a poor quality is showing. The following section is visible:—

	Ft.	ins.
Coal (very impure, dipping north 10 degrees east)	7	4
Sandstone and shale	67	5
Coal (impure, dipping west 25 degrees south at 22 degrees)	5	9
Black carbonaceous shales	7	0
Alternate bands of coal and shale	40	5
	127	11

Nodular clay ironstones and shales overlie the upper seam of coal.

In Jones's Selection, No. 1311, several seams of coal of considerable thickness are visible in the bed of a small branch of Tanyalba Creek. They dip west 10 degrees south at 40 degrees. The following section is visible:—

	Ft.	ins.	
Brown sandstone	23	0	
Clay	0	6	
Coal	1	11	
Black coaly shale	0	2½	Seam I.
Coal	1	4½	
Fireclay	0	8	
Coal	0	9	
Fireclay	3	9	
Coal	0	6	
Clay	0	4	
Coal	0	9	
Clay	0	7	
Coal	0	7	
Clay	0	9	
Coal	3	6	Seam II.
Sandstone	1	0	
Clay and black shale	3	0	
Coal	0	2	
Clay band	0	2	Seam III.
Coal	1	2	
Shale	1	4	
Grey sandstone...	0	11	
Coal	1	6	Seam IV.
Sandy shale, with two thin beds of coal (covered with water)	19	4	
Hard brown sandstone...	6	0	
Black shale	1	9	
Coal	3	0	Seam V.
	78	6	

About two chains higher up the creek, and overlying Seam I, a seam of coal, 3 feet thick, is said to occur in a waterhole; at the time of my visit it was covered with water. I was informed that this seam is not dipping so steeply.

Brown sandstone, dipping west 30 degrees south at 22 degrees is visible about 150 yards higher up the creek.

At the northern boundary-fence of the selection (higher up the creek again), coal 3 feet in thickness can be seen in a waterhole. This seam was partially covered with water. It is a bright coal of good quality (*see* analysis below).

Following the creek up above the selection, sandstone is visible, dipping south-west at 30 degrees; and higher up the creek again laminated and thin-bedded sandstones are dipping south at 35 degrees.

These beds are lying in the form of a small basin, and it is probable that the seam in the waterhole on the northern boundary of the selection is the same as No. I., the character of the coal and the analysis being very similar. (Plan 3.)

Analyses of the coal:—

	Seam I. Per cent.	Seam II. per cent.	Seam V. per cent.	Seam in Waterhole. per cent.
Water	2·5	6·0	14·0	5·5
Volatile hydrocarbons...	26·1	22·4	30·0	28·7
Fixed carbon	62·9	51·1	39·5	51·3
Ash	8·5 (grey)	20·5 (reddish)	16·5 (grey)	14·5 (grey)
	100·0	100·0	100·0	100·0
Coke	71·4 per cent.	71·6 per cent.	53·0 per cent.	65·8 per cent.

The specific gravities of the coal are:—Seam I., 1·32; Seam II., 1·38; Seam in waterhole, 1·38; Seam V.—the coal in this seam was very soft, and would not hold together. The coke in each case was non-caking.

The

The coal from Seam I. and from the seam in the waterhole was bright and hard; the former is some of the best coal I have seen in the district.

The high angle of dip, however, is very much against the seam being worked profitably.

The carriage would also be a great difficulty, as a line would have to cross the Mary River to join the Gympie and Maryborough line, or the Munna Creek to join the Kilkivan Branch Railway; the distances would be about six and ten miles respectively.

Mr. Wade's Selection, No. 19.—About five miles north-east of Jones's selection, and on the eastern bank of the River Mary, a sheet of hornblende porphyry, in a hard-baked slate, dips east 30 degrees north at 10 degrees, and forms a small "escarpment" along the side of a low range. Overlying this is a hardened sandstone, almost a quartzite, and above this again is a coarse ironstained sandstone.

Colours of gold have been obtained in a gully running down the side of this range. I tried a few dishes, but could not obtain a trace of gold.

About two miles north, in selection No. 13, there is a section of black coaly shale, 3 feet in thickness, in sandstone. Dip, north 30 degrees east at 30 degrees.

In Selection No. 1737, belonging to Mr. Sorenson, about half-a-mile south-east of the above, a seam of coal crops out in a gully, and dips north-east at 25 degrees. The seam is about 2 feet 6 inches thick, with sandstone above and below. The coal was partially under water, and is very soft.

Analysis:—

	Per cent.
Water	12·0
Volatile hydrocarbons	34·2
Fixed carbon	32·8
Ash (white)	21·0
	100·0

Coke (non-caking) ... 53·8 per cent.

Mount Bopple is situated about five miles south of Tiaro. The country between Tiaro and Mount Bopple is very flat, and no sections of the rocks are visible. The mountain itself is covered with a dense scrub. Near the summit of the mountain, and immediately north of Mr. Drain's selection, No. 26, on the eastern slope, a section of rock about 36 feet in thickness is visible. Dip, north at 35 degrees.

The rocks consist of shales containing a fair percentage of graphite, of hard siliceous slate, and of bands of graphite, from 1 to 3 inches in thickness. A shaft and drive which were put in, have been closed by a landslip which has since taken place.

A few yards to the west of this section is a decomposed micaceous granite. The western slope of mountain consists to a great extent of granite, on the eastern slope the coal measures exist. The graphite occurs in the coal measures, which have been altered by contact with the granite, the graphite being the result of the alteration by heat of the coal of the coal measures.

Graphite occurs under similar conditions in several places on the Continent of Europe—viz., in the Urals, Germany, at Arendale in Norway, and at Craigman in Ayrshire, in Scotland.

Mr. Drain showed me some fairly pure pieces of graphite obtained by washing the raw material.

The following are analyses of pieces taken by me from the section. No. I. is a picked piece from one of the bands of graphite. No. II. is a sample made up of pieces of the shale and bands of graphite taken from over the whole of the section:—

	No. I. Per cent.	No. II. per cent.
Carbon	72·7	44·25
Moisture and volatile matter	6·3	7·00
Ash	21·0	48·75
	100·0	100·00

Lower down the mountain, about a quarter of a mile south-east of the above, a somewhat similar section is visible in the bed of a creek; the dip is the same. Still lower down the hill graphite occurs in a foliated shale in the bed of a gully. Below the shale is a hard altered sandstone.

I have no doubt that a marketable graphite could be obtained by washing the raw material.

The average price of graphite in America for the year 1888 was about £40 per ton. The returns were 400,000 lbs. of graphite, value 33,000 dollars.

In the railway cuttings between Bopple and Tiaro there are a few rock-sections visible. At 24½ miles from Maryborough the following section occurs:—

	Ft.	in.
Laminated sandstone	2	0
Blue shale	4	0
Laminated sandstone	4	0
Black shale	3	0
Sandstone	15	0
	28	0

The dip is east at 40 degrees. In the cutting an east and west fault is seen throwing the rocks down 10 feet to the north.

At 23½ miles is a volcanic agglomerate.

At 23 miles there is a conglomerate, the pebbles consist of porphyry and sandstone. Dip, south-south-west.

Near to Tiaro, sandstone and shale dip south at 25 degrees.

When in Tiaro I visited Mr. C. Powers' selection No. 102, on Tinana Creek, about five miles east of Tiaro. A seam of very impure coal, 15 inches thick, dips west at 30 degrees. A little above the seam in the same gully sandstone and shale dip west 30 degrees north at 40 degrees, while close to Tinana Creek —lower down the gully—the rocks dip east 10 degrees north at 30 degrees.

In

In Jocumson's Selection, No. 37, near Aurora Plantation, a seam of coal 13 inches thick dips west 20 degrees north at 20 degrees; above the coal is clay, and then sandstone; the floor is of hard shale. A little higher up the river thick carbonaceous shales dip east 20 degrees north at 35 degrees. A fault must occur between these sections.

Coal was obtained some years ago in a shaft in selection No 90, opposite Aurora Plantation. The shaft has fallen in. I was informed that the coal was 3 feet in thickness.

Redbank Creek.—In selection No. 76, on Redbank Creek, three miles west of Tiaro, coal-measure rocks dip east at 30 degrees.

In Leather's selection, No. 78, close by, there are several sections of black and blue shales, with thin bands of coal, dipping east-north-east at 30 degrees. In the creek about 200 yards above Leather's selection there is a seam of good bright coal, about 4 feet 2 inches in thickness, dipping east 35 degrees north.

Analysis :—

	Per cent.
Water	10·0
Volatile hydrocarbons	28·0
Fixed carbon	47·5
Ash (reddish-grey)	14·5
	100·0

Coke (non-caking) ... ... 62·0 per cent.

Below this is a small seam 9 inches thick.

In Wilson and Hart's Selection, No. 39, one a-half miles west of Aurora, there is a seam of bright coal, 13 inches thick. It is nearly perpendicular.

At the bridge over Myrtle Creek the following rocks are dipping east 20 degrees north at 43 degrees :—

	Ft.	ins.
Shales with thin sandstone	8	0
Sandstone	5	2
Shales with thin sandstone	11	4
Brown sandstone	2	6
Shales	8	0
Brown sandstone	18	0
Shales	9	0
	61	0

I visited next Poona Creek, near Tin Can Bay, where boring has been carried on for coal in several places. The only section visible at all resembling coal was a bed of black carbonaceous shale dipping east 20 degrees north at 30 degrees. This is the general dip in this neighbourhood.

For the purpose of comparison I append in a tabular form the analysis of the various coal seams mentioned above, and also of some coals from the Burrum.

——	Water.	Volatile Hydro-carbons.	Fixed Carbon.	Ash.	Specific Gravity.	Coke.
Seam in Bull's selection	7·0	8·6	68·4	16·0	1·50	84·4 (non-caking)
Munna Creek top coal	6·0	22·6	49·9	21·5	1·43	71·2 „
Do. bottom coal	5·0	29·0	48·5	17·5	1·56	66·0 „
Jones's selection, Seam I.	2·5	26·1	62·9	8·5	1·32	71·4 „
Do. Seam II.	6·0	22·4	51·1	20·5	1·38	71·6 „
Do. Seam V.	15·0	30·0	39·5	16·5	...	53·0 „
Do. Seam in waterhole	5·5	28·7	51·3	14·5	1·38	65·8 „
Seam in Sorenson's selection	12·0	34·2	32·8	21·0	...	53·8 „
Seam in Redbank Creek...	10·0	28·0	47·5	14·5	1·51	62·0 „
Queensland Collieries Company's Seam ...	2·50	30·35	64·3	2·5	1·24	66·8 (caking)
Torbanlea Seam (Torbanlea Colliery)	2·25	29·15	66·5	2·1	1·26	68·6 „
Burrum Seam (Torbanlea Colliery)	2·75	28·00	65·55	3·25	1·27	68·6 „

The high percentage of water and ash in the coals from the Tiaro district is due, to a great extent, to the specimens for analysis being taken from the outcrops of the seams. The high percentage of ash would account, too, for their high specific gravity.

These coals would probably be of good quality at a depth, and from their structure I think they would be of a harder character than the Burrum coals.

The samples, from the Queensland Colliery Company's Mine, and from the Torbanlea Mine, were taken from depths of 100 feet and upwards.

It will be observed that the coals from the neighbourhood of the Burrum form good coherent cokes, while those from the Tiaro District are non-caking.

Gympie Beds.

Beds of the same age as the Gympie beds—carbonifero-permian—as before mentioned, lie to the west and south of the coal measures.

They consist of shales limestones, altered sandstones, and conglomerates. They have a general "strike" of about north-north-west, and dip steeply east-north-east.

Very little mining has been carried on in these beds in the Tiaro district.

Mr.

Mr. Scougall, of Glengarloom, has been prospecting for gold on a low ridge, called Mount Ruby, situated about half-a-mile west-north-west of Glenbar Head Station.

The country between the head station and Mount Ruby is of limestone and shale. On the ridge itself is a small sheet of a granitoid rock which divides the bed of limestone into two. This granitoid rock increases in thickness on the next ridge north-west of Mount Ruby.

Gold was first found in the surface soil, and that led to the ridge being prospected. Two shafts, one 40 feet in depth, and two or three open cuttings have been put in.

The gold appears to be in leaders in the granite, and in hard altered sandstone and quartzite.

The 40 feet shaft is in an altered serpentinous rock, with veins of calcite throughout it. Small veins of quartz, full of iron and arsenical pyrites, carry a little gold. Some of these veins dip at a very low angle in a northerly direction, and contain zinc-blende in addition to the above-mentioned minerals. The sinking of the shaft was stopped, owing to the hardness of the rock.

In the second shaft, 15 feet deep, there is a hard altered rock with chloride on its facets. There are two flat veins of gossan in this shaft about 1 foot each in thickness, containing veinlets of limonite, and stains of carbonate of copper. I obtained fair prospects of gold from these veins.

A cavity, filled with light sinter, occurs at the bottom of the shaft. It is about 3 feet across, and its sides are lined with gypsum.

In a cutting west of the shaft, leaders in granite dip north-north-west at 45 degrees, and carry fine gold.

I tried five prospects and obtained gold in all; two of them gave good prospects.

The veins are small and very irregular, coming in and dying out in a few feet; unless something more permanent is met with the place will not pay to work.

Traces of copper were met with in a lode of about 18 inches wide in the limestone on Mt. Allen, selection No. 1199, on Gigoomgan Run, four miles south of the head station. A shaft was sunk to a depth of 40 feet, but the lode did not improve. Mr. Allen informed me that he had found nickel ore on this hill.

In selection No. 248, on Munna Creek, near Merodian stockyard, there is a lode running north 30 degrees west, 2 feet 6 inches wide, in limestone. It contains stains of carbonates of copper in a quartz and calcite matrix.

A little gold was found in the casing.

Neardie Antimony Mine.—The Neardie Antimony Mine is situated in selection No. 1312, about twelve miles west of Gunalda Railway Station, in the Gympie shales, *south* of the coal measures. The lodes are in the same series of shales as the Exhibition, Enterprise, and Veteran reefs—the thick masses of shales which overlie the auriferous beds of Gympie, referred to in my report on the Gympie Gold Field.*

The Neardie mine is seven miles north of the Veteran Reef.

Traversing the road from Gunalda to Neardie, the first ten miles are over the coal-measure rocks. The Gympie shales appear for the first time about two miles west of the mine, and continue down to Tinana Creek, when the coal measures come in again and continue away to the coast.

The Neardie Antimony Mine has been worked, on and off, since the year 1873. The Neardie Antimony Company—the original owners—worked it from 1873 to 1876; they did not make it pay. Then a man named Ahrenfeldt leased it on tribute from 1876 to 1878, but did very little with it. In 1881 it was leased on tribute to Mr. H. E. King, as managing director of the Wide Bay Antimony and Smelting Company. This company, I am informed, did well by sending ore home direct, even at its low price at that time. They then put up furnaces and flues, and liquated the ore, sending it home as "crude antimony," which is merely the sulphide of antimony obtained by a process of liquation; the portion that would not liquate was oxidized and caught in the flues. They did not, however, obtain so high a price for the "crude antimony" as they were getting for the ore; and this, together with a lawsuit with the original company, as to whether the liquated sulphide was smelted antimony or not—they having to pay a higher tribute for smelted antimony—drove the company into liquidation in 1883. The mine was then idle until 1886, when it was sold, on conditions, to the Neardie Antimony and Smelting Company. It was worked by this company until the early part of this year. They took out a large quantity of good ore, but the expenses of the furnaces and liquation, and the low price of antimony at the time, caused them also to go into liquidation, the mine being thrown on the hands of the original owners again.

So far as I am able to gather from information supplied to me, about 1,139 tons of ore and "crude antimony" have been sold from the mine. Of this about 250 tons of ore, won by the original company and by Mr. Ahrenfeldt, fetched a little over £10 per ton. The Wide Bay Antimony and Smelting Company and the Neardie Antimony and Smelting Company sold 890 tons of ore and "crude antimony" at prices varying from £8 15s. per ton to £17 10s. per ton.

The New South Wales returns for the ten years 1872 to 1881 show that in that colony 1,072 tons of antimony (metal ore and regulus; the proportions of each are not given) sold for £28,616 or an average of £26 13s. 9d. per ton. At the present time the price of antimony is higher than it has been for a long time. Quotations in the American Mining Journal are:—

20th July, 1889.—Star regulus	... ...	£61 to £63	per ton.
Crude antimony	... ...	31 to 33	„
50 per cent. ore	... ...	18 to 20	„

The ore from the mine is of a good quality, and can be "picked" up to between 50 per cent. and 60 per cent. At the present prices it should pay to work if there is as good ore in the bottom level as there was in the upper ones.

Up to the present, work has been carried on on one lode only, and on but one "shoot" in that lode. There has not been sufficient prospecting for fresh "shoots," nor have the other lodes that are known to exist been sufficiently tried.

The

* "Report on the Gympie Gold Field," page 12, by the author. Brisbane: By authority, 1889.

The following is a description of the mine as far as I could see it at the time of my visit. The lower level could not be inspected as it was under water:—

176-*feet Level.*—Immediately west of the shaft is a small lode; it bears north 10 degrees east, and underlies east 10 degrees south at 20 degrees. This lode has not been worked at this point.

The main lode is 25 feet west of the shaft and parallel with the small lode. The shales run parallel to and dip with the lode. The northern level is 200 feet in length. (Plan 4.)

The lode consists of broken shale with small quartz veins. The principal "shoot" of ore was a few feet south of the face; this "shoot" has been worked out from the 336-feet level to the surface. The "shoot" dips about 35 to 40 degrees to the north; at this level it was about 40 feet in length; it widens going down so that at the 336-feet level it was 100 feet in length. The ore in the "shoot" was very good; all of it that was sent away went between 50 and 60 per cent.

The walls are of shale, and are smooth and well-defined the whole way along the level, except where the "shoot" of ore occurs, and there the walls become uneven and ill-defined, and consist of a soft greyish sandstone, coated with a thin facing of plumbago. When the plumbago faces are absent the ore dies out. There was but little quartz in the lode in the richest parts.

The ore in the "shoot" did not run at all regularly, but was sometimes on one wall, then on the other, or at times in the centre of the lode.

The lode in a "rise," 15 feet above this level, is 4 feet wide; on the footwall there are 8 inches of quartz and shale mingled together, containing stibnite—sulphide of antimony—throughout it.

A second and smaller "shoot" of ore occurs 40 feet south of the main one. The stibnite in this was in specks, not in needle-shaped or prismatic crystals, as in the main "shoot."

One hundred feet along the southern level, there is an old perpendicular shaft in which the lode, which is 15 feet east of the main lode at the main shaft, was worked by tributors, who took out from 100 to 150 tons of ore. Nothing was found in the main lode in the southern level, so far as it was driven.

295-*feet Level.*—The main lode here is 8 feet west of the shaft. An eastern crosscut has been driven 80 feet in length. Sixteen feet from the shaft, the small lode already mentioned was passed through; no work was done on it. At 29 feet east of the shaft there is a small quartz leader, said to contain 1 oz. of gold to the ton. A lode occurs 67 feet east of the shaft containing antimony ore, and, according to Dr. March, of Maryborough, silver and gold in small quantities.

At the end of the southern level on the main lode, 150 feet from the shaft, 8 tons of ore were taken out of a winze. This ore dressed up to 60 per cent., and sold at £17 10s. per ton.

The northern drive is 300 feet in length. The same conditions were met with as in the northern drive of the 176-feet level, except that the main "shoot" of ore was longer—about 100 feet in length—and the small "shoot" south of this, was going down straighter.

336-*feet Level.*—I could not inspect this level as it was under water. I am indebted to Mr. Geo. Power for the following notes:—

The northern level is 500 feet in length. The lode at the end of the level is displaced by a fault running north-west, and dipping north-east. No attempt has been made to pick up the lode north of this fault.

The ground in the neighbourhood of the fault was much disturbed, and was dangerous to work in.

Small crosscuts were driven eastwards to the south of the fault, but they were stopped on coming in contact with the fault.

Two hundred feet north of the shaft, a lode underlying west came into the level. It was "stoped" for about 100 feet in height, and about 120 feet in length. The ore was of a good quality. The lode varied in width from from 4 to 18 inches.

The total depth of the shaft is 527 feet, but no levels have been opened up below the 336-feet level.

No attempt has been made to find the lode to the north of the fault, and from the direction of the underlie of the lode, and the dip of the fault, I am of opinion that it will in all probability be found to have been shifted to the west. Very little has been done in the way of prospecting for new "shoots" and lodes.

Large masses of oxidised ore have already been discovered on the same line of lode in the Maryborough Block—Selection No. 319—to the north of the Neardie Mine.

The following is a short description of the method in which the ore was treated:—The ore was first broken up into small pieces of about the size of road metal. It was then picked over, and the best ore was bagged for shipment home. The finer particles were separated in a Cornish jigger and then bagged.

The poorer classes of ore were heated in a reverbatory furnace, with a bed 12 feet by 20 feet, and with a hollow in front of the bridge. The ore was first placed in this hollow, and when the "crude antimony" had been liquated, the remainder was turned over on to the flat part of the bed where it was oxidised.

The oxide of antimony was carried over, and deposited in flues. The flues are 800 feet in length, with a chimney stack at the end.

The following diagram shows the arrangement of the flues. (Plan 5.)

Granite.

Several copper lodes have been worked in the granite lying to the west of the beds of shale and limestone. The granite at Teebar is a continuation of the Doongal belt. It is a syenitic granite consisting of hornblende, felspar, quartz, and a little mica.

Teebar Copper Lode.—This lode is situated on the northern side of Munna Creek, about a mile and a-half west of Clifton Station. It bears north-north-east and underlies east-south-east at 10 degrees. The lode is 2 feet 6 inches in width at the surface, but widens out to 3 or 4 feet at 60 feet in depth. Near the surface the ore consists of oxide and carbonates of copper. At the water-level, which is reached at about 60 feet in depth, the sulphurets appear, and at 120 feet in depth there is, I was informed, about 16 inches in width of copper pyrites in a matrix of quartz.

Good

Good assays for gold have been obtained from the oxidised ores by a Mr. Higgins, who was in charge of the mine.

The shaft was put in order in the early part of this year, but owing to the fall of copper again, the lode was not worked.

Several parallel lodes have been fossicked about within a few hundred yards of this, but no real work has been done on them. They are all of a very similar character—gossan outcrops coloured with carbonates of copper.

In the event of the price of copper rising again, the mine will feel the advantage of the Mungar and Gayndah Railway, the first section of which is now completed, terminating within two and a-half miles of the mine.

A number of copper lodes runs in the granite on Gigoomgan Run, but they have not been worked for some years past.

In selection No. 1217 a lode runs east-north-east, between a grey granite and a quartzite. Specimens of rich grey oxide can be seen in the old paddock. The matrix of the lode is apparently quartz.

A peculiar lode occurs in selection No. 1822, on Filly Flat, about one and a-half miles east of the above, at the junction of the granite and limestone.

The lode bears north 30 degrees west. The matrix consists of large white crystals of orthoclase felspar, in which there is colourless and violet-coloured quartz, and nodular masses of light-green crysolite (olivine); disseminated through this matrix is copper pyrites, in pieces from the size of a pin's head up to about an inch across.

Some work has been done on this, but the percentage of copper is too small.

The Munna Mine is situated about three miles east-south-east of the above, in selection No. 135, close to the Munna Creek. The lode bears north-north-west, and underlies east-north-east. The lode at the surface is about 4 feet in width. The matrix of the lode is a decomposed granite.

West Culgoa Lode is situated in selection No. 1393, about four and a-half miles south-west of the Munna Mine.

The country rock is granite. The lode runs north-east and is nearly perpendicular. At the surface it is about 4 feet in width. Leaders of quartz containing carbonates of copper and galena occur in a mass of granitic lode stuff with copper and arsenical pyrites.

This lode was worked on tribute. The ore was dressed, carted into Maryborough, and shipped to Newcastle for sale, and with these expenses the men made a profit of £3 10s. per man a week.

Several other copper lodes have been prospected in this neighbourhood, but nothing can be seen of their workings. Among these may be mentioned the Louisa and Lug-e-nor. They are of very similar character to the Culgoa lode, but do not contain so much galena. I found some chrysocolla—a hydrous silicate of copper—which had come out of the Louisa shaft.

Running Creek.

Alluvial gold has been worked for some years back on Kolo Flat, near Running Creek, about seven miles east-south-east of the Culgoa Reefs. Nuggets up to one or two ounces in weight have been found with quartz attached to them, showing that they could not have travelled any distance. As yet no payable reef has been discovered, though one or two small ones have been opened up. The country here consists, for the most part, of a well-cleaved slate. In the absence of any evidence as to their age, I have in the map included them in the Gympie beds.

A tunnel was driven 234 feet in a southerly direction into the ridge on the side of the flat; it passed through a dyke of felspathic rock, which was mistaken for a reef; and near the end through a small leader of calcite, carrying by assay, 7 dwt. of gold per ton. The Three Bells Claim is lower down the flat, and below where the best gold has been got. In the upper shaft a vein of calcite is said to carry a little gold; this shaft is now abandoned. In the shaft lower down, and in the flat, there is small leader of quartz running east-north-east. It averages about 7 dwt. of gold to the ton. Some of the quartz shows free gold, and I obtained fair prospects from some quartz in which no gold was showing, but scarcely good enough for the size of the reef.

The country was of grey and black siliceous slates. A little alluvial gold was found on Yorkey's Hill, near Yorkey Creek, in selection No. 649, about three miles west of the above, but it was never worked. The hill consists chiefly of granite, with a dark siliceous slate and quartzite on the north-eastern flank. The slates strike west-north-west and dip very steeply to the south-south-east.

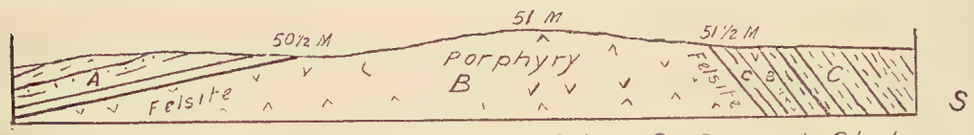
Before closing this report I must mention the occurrence of a large lode of barytes—sulphate of barium—in Mr. Ogilvie's selection, No. 648. It is about half-a-mile up Cut Log Creek from its junction with Running Creek. According to the returns from America, in the year 1887, 15,000 tons of barytes were sold for 75,000 dollars, or at an average of £1 per ton; in the year 1888, 20,000 tons were sold for 110,000 dollars, or at an average of £1 2s. per ton. The cost of carriage will prevent a lode of barytes situated as this is from being worked.

Price 5d.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

Section in Railway Cuttings Two Miles South of Curra.

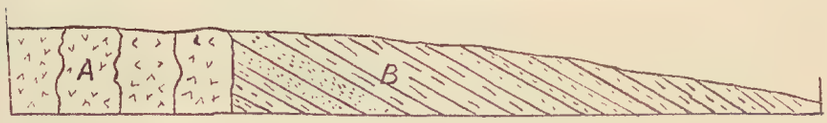
Plan No 1.



A. Burrum Beds. B. Porphyry and Felsite C. Gympie Shales.

Section in Tiaro Railway Cutting.

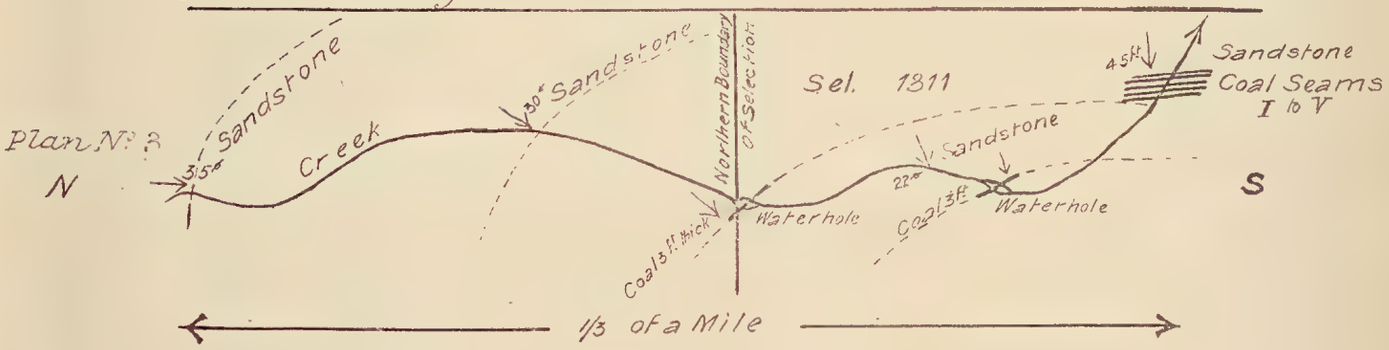
Plan No 2.



A. Intrusive Porphyry. B. Coal Measures Sandstones and Shales

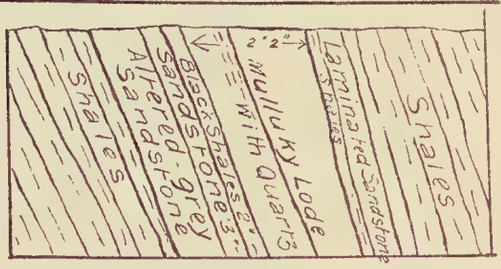
Plan shewing seams of Coal in Jones Selection No 1311

Plan No 3

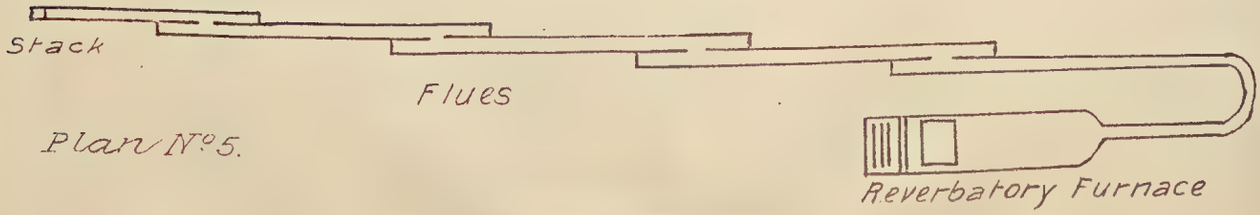


Face at end of Northern Level.

Plan No 4.



Plan No 5.



GEOLOGICAL MAP

To accompany Report on

TIARO DISTRICT

By

WILLIAM. H. RANDS

Assistant Govt Geologist

Scale, 2 miles to an inch.

REFERENCE

- **Coal Measures** (Burrum series) — A
- **Gympie Beds** — B
- **Granite Porphyry** — G P
- **Seams of Coal**
- **Lodes & Reefs** (Triangle shows direction of underlie and the number denotes the amount of underlie in degrees) — 25°
- **Dip of Strata** (Number denotes amount of dip in degrees) — 15°
- **Highly inclined Strata**

Owanyilla
Porphyry Dyke
Tiaro
Porphyry
Conglomerate
Volcanic Agglomerate
Brown S. & Shales
Sandstone
Boppie Stn.
Mt BOPPLE
Shales with Beds of Graphite
Brown Sandstone
Gundiah Stn
Gutchie Stn
Tiaro Coal Measures
Flat Wallum country
Mt BERERUM
Mt WOOGOO
Mt BENARIGE
Mt RUBY
Mt JOSEPH
Siliceous Slates
Mt ALLEN
Mt NEERDIE
Mt BOOKER
Mt EATON
Mt GOOMBOORIAN
SOUTH GOOMBOORIAN
Teebar Ck
Aramara Ck
Munna Ck
Taylors Ck
Soldens Ck
Large Ck
Jacky's Ck
Deep Ck
Oonamera Ck
Middle Branch Ck
Violet Ck
Myrtle Ck
Turkey Ck
Tinana Ck
Dry Ck
Spring Ck
Joshua Ck
Munro Ck
Calcoa Ck
Sandy Ck
Marodian Ck
Munna Ck
Running Ck
Cut Log Ck
Mira Ck
Brooyar Ck
Tansyalba Ck
Wide Bay
Bongmullerah Ck
Kilkivan Ck
Slate Ck
Hooley Ck
Currie Ck
Ulirah Ck
Red Ridge Ck
MARYBOROUGH & GYMPIE RAILWAY
KILKIVAN BRANCH RY
MARY RIVER
Kilkivan Junction
Gunalda Stn
Neerdie
TEEBAR COPPER SELECTIONS
GAGOOMGAN COPPER SELECTIONS
CULGOA COPPER SELECTIONS
Yorkey's Hill
Approximate boundary of Coal Measures
Boundary of Gympie Gold Field
Basalt
Limestone & Shale
Conglomerate & Shale
Sandstone
Shales
Coal
Blue shale
Thin Coal in creek
Impure Coal 16" thick
Brown Sandstone
Black Shales
Coal 2'6" thick
Freestone
Shales & Porphyry
Thick seams of coal
Black shales
Sandstone Shale Limestone
Grey & Black slates
Barytes Lode
Slate and Quartzite
Black carbonaceous Shales & sandstone
Sandstone & Thin Coal
Altered Porphyry
Porphyry & Felsite
Fissile Shale
Sheet of Felsite
Fissile Shales
Kannigan Range
Felsite
Shaft 10ft deep Anthracitic Coal 18" thick at 41'
Coarse Fissile Shales
Gabbro
Flat Sandy Wallum country
Free Stone
Lodes
Thick Coal Seam 20' of Coal
Coal 1965
Coal 13" thick
Coal 3" thick
Coal 4" thick
Coal 2'6" thick
Aurora Plantation
Dyke of Porphyry
Sheet of Felsite
Fissile Shales
Sandstone & Shale
Porphyry & Felsite
Fissile Shale
Sheet of Felsite
Fissile Shales
Gabbro
Barytes Lode
Lode
Lode

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1890.

QUEENSLAND.

NATIONAL GALLERY OF VICTORIA.

PROPOSED BORING FOR ARTESIAN WATER ON THE ETHERIDGE AND CROYDON GOLDFIELDS.

(REPORT BY ROBERT L. JACK, GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

ETHERIDGE GOLDFIELD.

The whole of the country in the vicinity of the old mining centres within the Etheridge Goldfield is situated either on granite or mica-schist. Bores would, in all probability, disclose no material change in these rocks, unless perhaps mica-schist at the surface might be succeeded by granite beneath.

In my report on the proposed boring at Brisbane I entered so fully into the question of the conditions under which artesian water is found that it is unnecessary to go over the same ground again. It is enough to say that the rocks of the Etheridge Goldfield are such that, beyond the limit of atmospheric influence, they may be expected to be so compact as to be quite impervious to meteoric water. The only hope of successful boring for overflowing artesian water lies in the chance of accidentally coming upon an open fissure communicating with the surface. The probabilities against such an accident are at least 1,000 to 1, and the risk is so great that I cannot recommend the Government to undertake it.

Two suggestions made in the course of a debate on the subject in the Legislative Assembly on 10th October, 1889, may be referred to here.

The first suggestion was that the reefs of a goldfield themselves might furnish overflowing artesian water, and it was mentioned that in the shaft of the Hope Mine, Charters Towers, water enough to swamp out the mine was met with. The water, however, in this case did not rise to the surface.

It is true that reefs *were* once fissures, although most of the fissures have now been filled up with mineral matter. In some instances the filling-up may be still incomplete, and in such cases water may find its way from the surface to such depths as the openings extend to, and on being tapped by a bore will rise to the permanent water-level—say 60 to 100 feet from the surface. But the common experience is that for one reef open enough to permit of the passage of water beyond a depth of 700 or 800 feet there are a thousand which are completely filled with mineral matter.

The second suggestion was that, as there are hot springs on both sides of the Etheridge and Croydon Goldfields, the sources of these springs may lie beneath the goldfields in question. The hon. member who made this suggestion was kind enough, in reply to a telegram, to give me some information regarding the springs referred to. The springs are situated, one on the Einasleigh and the other on Taldora Run. The latter was described by Daintree in 1872. The former I visited in November last, and intend to describe in my report on the Etheridge Goldfield.*

It is highly improbable that a continuous underground hot-lake extends from the Einasleigh to Taldora, a distance of 200 miles, beneath the granite and other rocks of the district, though it is not impossible that isolated reservoirs of hot water only waiting for an artificial opening to be forced to the surface by expansion following on the relief of pressure, may exist in unsuspected places.

The temperature of that portion of the earth's crust accessible to observation has been found to rise about 1 degree F. for every fifty or sixty feet of depth, so that water could not be heated up to 212 degrees before the depth of 7,100 feet (taking the surface temperature at 70 degrees and the increase at 1 degree in fifty feet) had been reached. The deepest bore in the world is said to be 5,735 feet (near Leipzig), and I believe it is only under exceptionally favourable conditions, and with exceptionally good apparatus, that anything like that depth could be attained. But the boiling-point of water is raised by pressure in a ratio which increases much faster than the rate of increase in the temperature of the earth's crust, so that water could *never* be raised to the boiling-point by the normal increase in the internal heat of the earth alone. At the same time, though water would not *boil* from the internal heat of the earth, the expansion of heated water in a pipe (whether natural or artificial) might force it to flow out at the surface as a spring or artesian well. I know of no *data* by which the presence of underground reservoirs at sufficiently great depths to be expanded by the internal heat of the earth can be detected. Haphazard boring for such reservoirs would, I fear, be too expensive an undertaking for any speculator, or even for any Government.

Rocks of igneous origin (*e.g.*, basalts) may (and in some cases must) still retain, at reasonable depths, enough of their original heat to raise any water which may come in contact with them to the boiling point. But the contact must take place at a depth so shallow that the pressure of superincumbent water

* The hon. member's telegram contained the following paragraph—"Springs reported on Gilbert River." This doubtless refers to a highly-coloured account of a hot spring containing gold in solution, said to have been discovered by a prospecting party who were dispersed by the blacks, so that the knowledge of the exact locality was lost. The story was a simple romance, written by a scientific gentleman in New South Wales, who makes no secret of the authorship, and had reference to one of the theories regarding the origin of Mount Morgan. The joke, however, overshot the mark and has been taken seriously by many miners and others; so much so that at least one expedition has been made in search of the auriferous spring.

water or rock shall not raise the boiling point of water above the temperature of the rock. Every lava-flow which appears at the surface must be connected with underground ramifications, consisting essentially of a reservoir and a channel. The material in both reservoir and channel may be, and in the case of ancient eruptions must be consolidated, but such rocks are very bad conductors of heat—in other words lose their original heat very slowly. The connection of hot springs in all parts of the world with recent, or, geologically speaking, not very ancient, volcanic rocks is now well known. It is safe to assume that for one case of water thrown to the surface by its expansion owing to the normal increase of the temperature of the earth with depth, there are hundreds of cases of springs due to the presence of heated igneous rocks at no very great depth beneath the surface.

In several of the valleys in the Etheridge Goldfield there are still to be found the denuded remains of basaltic lava-flows which are presumably of Tertiary age. Denuation has, however, for the most part removed all traces of the points of eruption. If, however, the Government desires to search for the underground continuations of these lava-flows on the chance (almost a certainty) that they still retain a large proportion of their original heat, and the further chance (degree of likelihood not ascertainable) that meteoric water comes in contact with them, the best places for the experiment would be in the valleys above the heads of the basaltic patches—for instance, on the Einasleigh about five miles below the hot springs.

CROYDON.

At the town of Croydon, and in the low land to the west, syenite rocks everywhere make their appearance at the surface, and extend to an unknown, and doubtless to what, for the present purpose, is practically an infinite depth. The hills to the east, however, are composed of a rock which will require much microscopic examination before it can be definitely named, but to which in the meantime the provisional term semi-vitreous quartz-porphyry may be applied. This rock apparently overlies the syenite. The reasons for this conclusion will be given in full in my report on the goldfield. At present it is enough to say that the syenite is as compact as the granite of the Etheridge, and that the semi-vitreous quartz-porphyry (of which a sample is sent herewith) is not more permeable than bottle-glass. Both are in the highest degree unfavourable to the presence of artesian water, although the bare chance of a bore striking an open fissure may be taken into consideration. As in the case of the Etheridge, I consider that the chance is so infinitesimal that I cannot advise the Government to spend money on it.

GENERAL CONCLUSIONS.

In the case of the successful bores for artesian water in the western interior, the water rises to the surface with temperatures varying from 101 to 119 degrees. It is obvious, therefore, that the water has come from a depth at which the normal heat of the earth's interior, or the heat still retained by subterranean igneous rocks, could raise it to the above high temperatures, and even possibly, by the expansion of the heated water, assist in expelling it from the artificial openings. But in order to bring about these results it is necessary that, in the first place, water should have found its way through porous strata to the depths at which it could come in contact with the heated rock. This condition is present in perfection in the "Rolling Downs" (Cretaceous) formation on which the artesian wells are situated, but is entirely absent from the Etheridge and Croydon Goldfields. For this reason I cannot advise the Government to bore for artesian water on either field.

As, however, my instructions are in the following terms:—

> "*Memo. for the Government Geologist, Georgetown*—I am directed to inform you, the Honourable the Secretary for Mines desires that when examining the Etheridge and Croydon Goldfields you will endeavour to ascertain whether suitable sites for artesian boring exist thereon, and should you be unsuccessful in discovering undoubtedly *good* sites for the purpose named, you will report on any others best suited for trial bores, as the Government wish to test these fields.
>
> "(Signed) Glen Cameron, Acting Under Secretary, Mines,"

and as, at the same time, I see no reason for preferring one site to another, all alike being open to serious objections, it appears to me that in default of "*good* sites," the places "best suited for trial bores" are those where water is most urgently wanted in dry seasons. On this point I should prefer that the opinions of responsible local bodies, such as the Divisional Boards, should be given effect to. Failing recourse to this plan, I beg to point out the following localities where overflowing artesian water would be a convenience to the public, but I must add that I do not expect that it will be found—

On the Etheridge—(1.) Finnegan's (Charleston). (2.) The Durham. (3.) Lane's Creek.

On Croydon—(1.) In the low hills above Brown's Reservoir. (2.) At Table top.

Locality (1) at Croydon would have the advantage that the bore would, in the first place, settle definitely the relation of the semi-vitreous quartz-porphyry to the syenite; and in the second, test the extension of the Croydon, Queen, and Highland Mary lines of reef.

There is abundant evidence to show that Croydon can have sufficient water for its needs by sinking shafts and pumping. Although this method may seem too simple and primitive to those who are carried away by the idea that overflowing artesian water can be obtained anywhere if we only "bore deep enough," it appears to me that the field will in the future have mainly to depend on it. In spite of the construction of numerous dams during the last three years, the only crushing machines that have had sufficient water are those which have been partly supplied by water taken from the mines. The other reservoirs have either not been filled or the water has escaped through the dams or sunk beneath the surface. The universal explanation is that the reservoirs were in "bad holding-ground," which is merely saying, in other words, that, so far down as the influence of weathering extends, the rocks are fissured and open. The fact, however expressed, affords the safest grounds for believing that the water which *has sunk* is still to be found beneath the surface. That a vast quantity of water is to be found between the "water-level" and the depth beyond which superficial influences do not extend may be inferred from the compact and impermeable nature of the rock—the same consideration which forbids us to look hopefully on the prospect of obtaining overflowing artesian water.

ROBERT L. JACK.

Geological Survey Office,
Townsville, 18th January, 1890.

Price 3d.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

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1890.

QUEENSLAND.

PROPOSAL TO BORE FOR ARTESIAN WATER AT NORMANTON.

(REPORT BY ROBERT L. JACK, GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Having received your instructions to assist the Municipal Council of Normanton in fixing on a site on which to bore for artesian water, I employed Mr. Maitland, Assistant Geologist, to collect data and make a geological survey of the district. Mr. Maitland's Report is attached hereto (Appendix A). Before Mr. Maitland left I satisfied myself, by a personal inspection, of the correctness of his mapping and of the data which he had amassed.

The Desert Sandstone rocks, which are met with at an elevation of over 2,000 feet at the heads of the Gilbert, occupy lower and lower levels as they are traced to the north, and at Normanton reach the level of the sea. These strata being newer than the cretaceous rocks of the Rolling Downs formation, the latter may be present beneath. Seeing that it is in the open and porous strata of the Rolling Downs formation that the artesian water supply of the western interior is found, the question is narrowed down to a search for evidences of the existence of that formation in the neighbourhood.

In 1888, Mr. P. W. Pears, Police Magistrate, Normanton, presented to the Geological Survey Museum some fossils from Milgarra Run on the Flinders, about fifty miles from Normanton, which placed beyond doubt the presence of the Rolling Downs beds in that locality. Mr. Maitland's recognition of the same formation beneath the Desert Sandstone in the well at Magowra Station, fourteen miles from Normanton, forms another important link in the chain. There is every reason to believe that the Rolling Downs beds, although almost everywhere covered either by recent alluvium or by Desert Sandstone, extend continuously from Magowra on the south-west to the Walsh River on the north-east.

Taking these considerations into account I have advised the Municipal Council that in my opinion Normanton is favourably situated as regards the chances of obtaining artesian water, and that there is no geological reason why a bore should not be put down on the highest ground available. A copy of my letter to the Mayor accompanies this Report (Appendix B).

ROBERT L. JACK.

Geological Survey Office, Townsville, 20th January, 1890.

APPENDIX A.

REPORT TO R. L. JACK, ESQ., GOVERNMENT GEOLOGIST, ON THE GEOLOGICAL FEATURES OF THE ENVIRONS OF NORMANTON, BY A. GIBB MAITLAND, ASSISTANT GEOLOGIST.

(*See Geological Sketch Map of Environs of Normanton.*)

The tract of country embraced in this Report lies between the Norman and the Bynoe Rivers, the latter merely an outlet of the Flinders, and is bounded on the south by a line running due east and west from Glenore ("The Twelve Mile") to the Bynoe; an extent of country comprised within an area of about 500 square miles.

The physical features of the district are marked by no conspicuous elevations, the highest land being not more than 100 feet above high-water mark at Normanton. The general aspect of the country is that of low-lying plains—with saltpans and fresh and brackish lagoons near the rivers—enveloping a low tableland, the Stokes Range, which rises on the west, overlooking the alluvial flats on the banks of the Bynoe, to an elevation of not more than 90—100 feet above the sea. Physically this range extends as far as the town of Normanton, and at this extremity the height above the high-water mark is about 40 feet.

The series of rocks occurring within the limits of the area described consist of—

(~) Recent Superficial Deposits.
(*D*) Beds presumably of Desert Sandstone Age; and
(*K*) Representatives of the Rolling Downs Beds.

(~)—*Recent*

(~)—*Recent Superficial Deposits.*

These cover a large area along the banks of the Norman and the Bynoe Rivers.

In the vicinity of Red Bluff, about 7 miles south of Karumba (late Kimberly) township, a salt-water arm or marine swamp, of considerable area, occurs. The materials forming this swamp consist of sandy clays, containing remains of marine animals and occasional pebbles. Some of these extensive flats have depressions on their surface, forming fresh and brackish water lagoons. The thickness of the clays forming these saltpans is in places very great; and after a heavy wet season the swamps are rendered well-nigh impassable.

Attempts have been made to manufacture bricks from some of these sandy clays, but doubtless owing to the varying percentage of saline matter, which nearly all coastal clays contain, the bricks are not such as will well withstand the intense heat to which they are subjected in the course of their manufacture.

At the Red Bluff, on the south bank of the Norman River, comminuted remains of shells of the species inhabiting the Gulf at the present day overlie the upper beds of the Desert Sandstone Series, at a height of 16 feet above the high-water mark. This is but a fragment of an old sea beach which existed in this portion of the country when the topographical features were somewhat different to those of the present day. These remains also afford evidence of the elevation of the land within comparatively recent times.

It is to be regretted that the time at my disposal did not allow of my separating and distinguishing by colour on the map accompanying this Report the different members of this series of superficial deposits.

(*D*)—*Desert Sandstone Series.*

Apart from the superficial deposits, the beds of the Desert Sandstone Series occupy by far the greater portion of the surface of the district.

In the absence of any trustworthy data, it is impossible to give any idea of their thickness.

A variable thickness of concretionary ferruginous sandstone, not unlike a conglomerate in appearance, forms the upper portion of the series. Beneath this lie clayey sandstones, red, brown, and even white in colour, which pass in places into rocks possessing all the characters of the true clays.

In the well sections seen within the Municipal boundary these sandstones are associated with clay, shales, and true clay beds, often lenticular in shape, and of no great horizontal extent, and which in colour are generally yellowish-white.

A bore put down in 1885 by the Carpentaria Divisional Board, at the junction of Thompson and Woodward streets, within the municipal boundary of Normanton, shows the following section:—

	Ft.	in.
Hard gravel	7	6
Ironstone rock	4	6
Clay	4	6
Mild rock (?)	33	0
Red clay	9	0
Rock	3	0
Pipe clay (?)	6	0
Yellow clay	9	0
Sandy clay	27	0
Yellow clay	7	0
Pipe clay (?)	7	6
Sandy clay	30	0
Yellow clay	39	0
Blue clay	8	0
Soft yellow clay	6	0
Blue clay	6	6
Black sandstone (?) ...	11	6
Total	224	0
Very hard rock		

The height of the surface of the bore is 37 feet above high-water mark, and its total depth is about 224 feet The water rose to a height of 22 feet from the surface. It is greatly to be regretted that no samples of the material passed through have been kept, more particularly the "very hard rock" met with, when it was decided that boring operations should cease. From an examination of the record as it at present exists, and from what is actually seen in the present well sections, the whole thickness of rocks is provisionally classed with the Desert Sandstone Beds. It is, however, probable that most of what are described as "clays" are not all true clays, but merely sandstones and shales containing a high percentage of argillaceous matter.

On the western side of the ridge upon which the Hospital now stands a quarry has been opened. The rock quarried is a very ferruginous fine-grained argillaceous sandstone, but the percentage of clayey matter is not so high as in the beds more immediately above. Beneath this, now covered by water, lies a bed of fairly porous reddish sandstone, the thickness of which has as yet been undetermined. The escarpment of these beds can be easily traced round to a point on the western bank of the Norman, within six yards of the bank of the river.

Similar sections are seen in a conspicuous cliff which can be traced along the Cloncurry road as far as the Four-mile Creek, and also at intervals along the Burketown road, near selection 72.

At the Red Bluff, twenty miles north-west of Normanton and on the western bank of the Norman River, a tableland of Desert Sandstone, identical in physical characters with that forming the rest of the district, occurs. Its summit is 16 feet above high-water mark, and nowhere is the lower portion seen, being concealed beneath the superficial accumulations which here attain a considerable thickness.

(*K*)—*Rolling Downs Beds.*

The only locality in the area examined where representatives of these beds are seen is in a well section at Magowra Station, on a ridge about 90 feet above the sea, and on the divide between the Bynoe and the Norman.

A very thin capping of concretionary sandstone of Desert Sandstone age overlies these beds.

The total depth of the well is sixty feet, and by far the greater portion is timbered; a descent into the well showed that the rock consisted of a fine calcareous sandstone, with a small percentage of argillaceous matter, and a thin band of clay about half-an-inch in thickness. The beds are horizontal.

During the course of sinking the well many fossils in a good state of preservation were met with; unluckily these, with one single exception, *Glycimeris Tatei*, have either gone astray or been destroyed. From descriptions of some of them, given by Mr. Stuart Russell, the manager of the station, there was little hesitation in recognising *Turrelites* as being one of the common forms. At Milgarra Station, fifty miles west of Normanton, *Crioceras australe* has been obtained by Mr. Pears.

Well nigh treeless black-soil flats occur over the Rolling Downs beds, on the road from Normanton to Burketown. On the black-soil flats around Magowra Station nodular concretions of argillaceous matter containing kernels of carbonate of lime are occasionally met with. In none of these broken open were any fossils detected.

The Water Supply from a Geological Aspect.

The water derived from the numerous shallow wells within the town of Normanton has been found to be quite inadequate to supply the public requirements.

The supply is at present derived from wells which are filled by mere surface percolation; hence its intermittent character, and its liability to pollution from want of proper drainage.

The wells in the town are of no great depth; the deepest at the time of my visit (December 1889) was about eighty feet, and in the whole, the strata seen were mainly argillaceous beds (destitute of fossils) of fairly uniform texture but of a variety of colours.

But

But few of the wells were able to withstand the drain upon them during the late drought; although two of them were capable of producing each about 600 gallons every twenty-four hours. Not a few contained water totally unfit for culinary purposes, owing to the percentage of saline matter held in solution. An explanation of this is not far to seek. Many of these argillaceous beds, being essentially marine deposits, are known to contain saline matter, and in the course of its underground passage it is not unnatural to expect that a certain quantity thereof would be removed by the waters in solution.

The circulation of the underground water is very irregular, by reason of the occurrence of lenticular bands of clay, which act as effective bars to its free passage; hence the difference of level of the water in adjoining wells only a few yards apart.

In some cases fissures of no great width, sometimes less than an inch, have been met with, and through them the water flowed freely for a time (until the small "reservoir" was drained), and then the flow ceased.

From an examination of these wells it appears that the water level varies from eighteen to thirty feet.

It will be seen from the description of the strata given above that at Magowra Station beds of Rolling Downs age have been discovered. It is these beds which in the western portions of the Colony act as the "carriers" of that water which has been tapped by the artesian bores. There is every reason to believe that these strata pass beneath the Desert Sandstone beds under that portion of the country upon which the town of Normanton stands.

The geological structure and physical features of the country are favourable for the possibility of artesian water being struck. The strata have been but little disturbed from the position in which they were originally laid down.

The collecting area, from which the water entering the permeable strata is derived, is far distant, and comprises a large extent of country—viz., on the west, that area of palæozoic strata which stands as an island in the midst of mesozoic rocks and of which the Cloncurry Gold Field forms the central part, and the waters of which drain into the Gulf of Carpentaria; and on the east, that tract of country of which the Etheridge, Gilbert, Croydon, and Woolgar Gold Fields form a part.

In the absence of a detailed survey with trustworthy topographical maps, there are no data available whereby the depth at which water will be met with can be estimated.

Before a supply can be tapped, the clayey strata, however thick, will have to be penetrated. Those at Manfred Downs are over 600 feet in thickness, and if the subjacent water-bearing sandstone is met with, the hope may be reasonably indulged in that within the environs of Normanton a supply of artesian water will be met with

A. GIBB MAITLAND,
Assistant Geologist.

APPENDIX B.

Normanton, 23rd December, 1889.

Sir,—I have the honour to report as follows:—The town of Normanton and neighbourhood are situated on the Desert Sandstone, except where the latter is covered by recent alluvial deposits.

Although the evidence is more meagre than could be desired, there is reason to believe that beneath the Desert Sandstone will be found the Rolling Downs formation, including the strata which, in the southern and western districts of the Colony, have proved to be sources of artesian water supply.

It appears to me, therefore, that a bore for artesian water may be put down at Normanton with a reasonable degree of confidence. As to the depth at which water will be found, there is not sufficient evidence to enable me to form even a conjecture. The Council should be prepared to bore at least 2,500 feet.

It would be a convenience to have the bore on the highest point within the Municipality, and there is no geological reason why it should not be placed in that position.

Should granite, or slate, or other hard palæozoic rock be met with, I should recommend the immediate stoppage of the work.

Permit me to impress upon the Council the importance of carefully preserving and labelling the borings or cores.

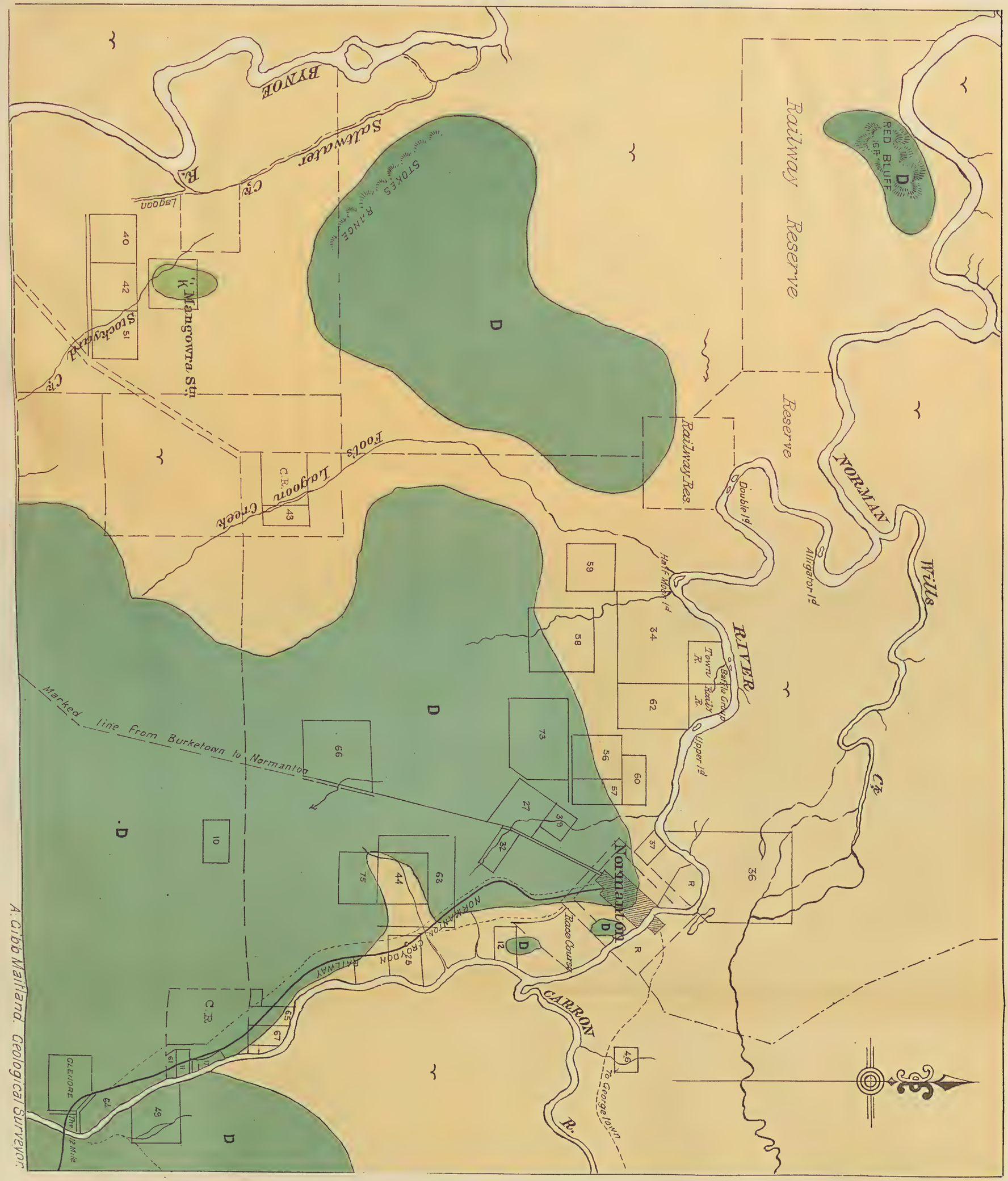
I have, &c.,
ROBERT L. JACK,
Government Geologist.

To His Worship the Mayor, Normanton.

Price 6d.]

By Authority: James C. Beal, Government Printer, William street, Brisbane

GEOLOGICAL SKETCH MAP
OF
ENVIRONS OF NORMANTON



NATIONAL MUSEUM VICTORIA

1890.

QUEENSLAND.

THE BROOKFIELD, PULLENVALE, AND MOGGILL DISTRICTS.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

In accordance with instructions received, early in December last I paid a visit to the above districts, which lie to the west and south-west of Brisbane, on the north side of the Brisbane River.

The rocks in the district belong to three different formations:—

1. Rocks belonging to the Ipswich coal beds.
2. Basalt.
3. Metamorphic schists, a continuation of those around Brisbane.

1. IPSWICH COAL BEDS.

A small patch of the Ipswich beds, of about seven square miles in extent, occurs in the Moggill "pocket" of the Brisbane River, north of Goodna. Mr. A. C. Gregory in his geological map of Moreton and Darling Downs coloured in this area as schists, making the Brisbane River the boundary between the Brisbane schists and the Ipswich beds. The Ipswich beds, however, cross the river near the mouth of Pullen Pullen Creek, and occupy the whole area within the "pocket."

Building Stone.—Freestone has been quarried for building purposes in several places.

In Mr. Fraser's selection, No. 135, a quarry was opened up on a white freestone, in the high bank of the river.

A quantity of this stone has been used in Brisbane buildings. On the opposite side of the river, immediately north of Goodna, there is another large freestone quarry.

A quarry is just being started by Mr. Lugars in selection No. 112, situated on the western side of the "pocket." The stone is of an even greyish colour, and of medium grain. It is a stone easily worked when freshly quarried, and it hardens upon exposure to the weather. Where the stone has been exposed at the surface it can scarcely be touched by steel.

It has every appearance of making a good and handsome building stone. The stone can be taken out in very large blocks.

A quarry was worked in selection No. 109, about a quarter of a mile south of this. The stone was white and of medium grain.

A bed of freestone occurs in Mr. T. Gibson's selection No. 159. It was very coarse in the grain, and would not stand the weather; wherever it is exposed it has crumbled up into loose sand.

Coal.—Coal is said to have been cut in a borehole which was lately put down to a depth of 80 feet in Mr. John Williams' selection, No. 14, on the river, opposite to Wolston Creek. A tunnel has since been driven in a westerly direction towards the borehole. The tunnel is about 100 yards in length, and is inclined at an angle of about 1 in 3, so that the end of the tunnel is about 100 feet below the surface. It has been abandoned for a few months, and is now more than half full of water.

The tunnel has been driven through soft sandstone, blue shale, and black carbonaceous shale, containing thin bands of coal. The dip of these rocks is S.S.E. at about 9 degrees, so that the tunnel is driven across the dip.

A straight shaft would have tested the ground in a far more satisfactory manner, and would have been far more convenient for working any coal when found.

Coal was worked in the adjoining selection, No. 15, over thirty years ago, by Mr. Fryar, the present Government Inspector of Mines, to whom I am indebted for the following notes:—"A detached fragment of a seam of coal from 10 to 12 acres in extent, at the south-east corner of portion 15, was worked during about ten years from 1848 to 1858 or 1859.

"The seam was from 5 feet 3 inches to 5 feet 6 inches high, with a considerable band of clay shale under the top 18 inches of coal, and an occasional band of inconsiderable thickness near the bottom. It was bounded on the east by the river at too shallow a depth to be worked with safety underneath, even if it had not been displaced in the channel; bounded on the north-east by the outcrop in the elevated ridge, near the river at that point; and on south-west or south-south-west by a fault or dislocation of the strata—evidently an upthrow in that direction. The line of fault was followed, but no coal found above, so that the surface had apparently been denuded of the counter part of that seam. Other seams are found in the gullies to the southward (one of which is believed to be identical with that recently opened up in the adjoining portion), but which have not hitherto been considered capable of being profitably worked.

"The dip of the seam varied both in amount and direction owing to its proximity to the fault, but, generally, it may be said to have been to the south-east at about 1 in 5, or say 11 to 12 degrees.

"The coal was of a fairly marketable quality, very similar to those now worked in the neighbourhood of Ipswich and Bundanba, and all the available supply was exhausted, there being only fragments of the perished coal near the surface left on the one side, the face of the stratum in dangerous proximity to the river-

river channel on another, and the bared dislocation on the third. A stone drift was driven into the strata which disclosed only the ordinary blue shales of the coal measures, and a small shaft sunk about 200 yards back was in sandstone—and a borehole put down in the bottom of the shaft disclosed more sandstone, shales, and thin layers of coal, but nothing of workable thickness."

The fault referred to by Mr. Fryar, as occurring to the S.S.W. of the coal, would run in a direction between E.S.E. and S.E.; and if, as he suspects, it has an upthrow to the south, the bed of coal to the south of the fault would lie away to the east, and not to the west where the trial shaft was put down. The other portion of the seam might therefore be looked for on the eastern side of the river; it might very probably be picked up, unless some other fault occurs, in the 500-acre reserve for pasturage for use of the Woogaroo Asylum.

Thin layers of coal in black and brown carbonaceous shales crop out on the side of the road, alongside Gibson's selection, No. 159. The rock here also dips S.S.E. at 14 degrees. This appears to be the general dip of the beds in this locality.

2. BASALT.

A band of basalt, of no great width, runs across the "pocket" in an east and west direction, between the Ipswich beds and the schists. It appears therefore to occupy a parallel position (the base of the Ipswich coal beds) to the ashy sandstone described in my report on Brisbane and its environs.* In this case the Ipswich beds of this locality would occupy the same horizon as those immediately east of the ashy sandstone in Brisbane. It is, however, impossible to speak with certainty on this point when examining such a very limited portion of the coal measures as are included in the district to which my instructions referred.

The basalt is a hard, compact, fine-grained rock, with minute blebs of olivine showing here and there. It is being quarried in the bank of the river in Mr. Sullivan's selection, No. 174. It is broken by a stone crusher, and taken to Brisbane in barges for road metal.

3. BRISBANE SCHISTS.

The schists which occupy the whole of the district, with the exception of the area above mentioned, are in all respects similar to those I have already described in my Brisbane Report, and in my Reports on the Albert and Logan District.†

Nothing but these schists are traversed the whole of the way from Brisbane along the Moggill road.

In Mr. Gregory's map a portion of the schists are coloured purple, and the remainder blue; the purple denoting schist of an older age. I examined that portion coloured purple very carefully, but I could see nothing in their composition, structure, or mode of occurrence to warrant any such distinction being made, and in the absence of any direct evidence I must look upon them as identical with the Brisbane schists.

The schists are first seen north of the basalt where they are dipping either perpendicularly or at a high angle to the north-east.

In Mr. G. Logan's selection, No. 201, on Moggill Creek, there is a bed of well cleaved slates, dipping south-west at 55 degrees. They crop out in the high bank of the creek.

The slate is of a dull bluish-grey colour. It occurs in large slabs which can easily be split along the lines of cleavage, or rather I should say of bedding, as it is not a true slate. With a small hammer I was able to split a slab, measuring about 3 feet by 1 foot 6 inches, into three without it breaking.

There is every probability that this slate would prove to be of considerable commercial value, were it to be opened up by a quarry. The opening up of a slate quarry, however, is generally a matter of great expense, and I do not think it would be advisable to do much with it at present, as the rate of carriage by road to Brisbane would be very heavy.

I was shown a place in the south-eastern portion of selection No. 194, from which a ton of ironstone had been taken and smelted by Messrs. Smith, Forrester, and Co., Brisbane. It produced 12 cwt. of iron. The place this stone was taken from was in rough hilly country. The stone was got from one of the quartz veins so common in this schistose country, in which there were patches of the oxides of iron and manganese. It is of no commercial value.

In the northern part of the same selection, close to Brookfield Creek, a reef is being tried for gold. It bears E. 30 degrees S., and underlies S. 30 degrees W. It runs parallel with the bedding of the schists, which form the country-rock. The width of the reef varies considerably; near the bottom of the shaft, at a depth of 40 feet, it is about 4 feet 6 inches in width, while at the bottom, at a depth of 44 feet, it is only 2 feet 6 inches wide. The walls are smooth and well defined.

The matrix of the reef is quartz, carrying a considerable amount of iron pyrites in parts, and now and again a little galena. A piece of the pyritous quartz was assayed (not an averaged sample); it yielded no gold or silver. The reef is of precisely the same character as those described in my reports on the Albert and Logan districts, and I regret that I cannot speak of it any more favourably than I did of those reefs.

Another shaft was sunk on a reef about 300 yards south-east of the above. The character of the stone is much the same. A ton of stone was crushed, and yielded 8 dwt. of gold. This shaft has been abandoned.

A reef of hard red jasperized quartz, containing iron pyrites, was tried; it yielded 20 grains of gold per ton. This was a short distance west of the above.

I did not visit the reefs known as the Gold Creek Reefs, as they have already been reported on more than once, and they were not at work at the time. I have seen specimens of these reefs, and the country-rock, and it would simply have been a repetition of those already reported upon.

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* Report and Map of the City of Brisbane and its Environs, by William H. Rands, Assistant Government Geologist. Brisbane: By Authority, 1887.

† Report on the Geology and Mineral Deposits in the neighbourhood of Beenleigh, &c., by William H. Rands, Assistant Government Geologist. Brisbane: By Authority, 1887. Report on the Albert and Logan Districts, by William H. Rands, Assistant Government Geologist. Brisbane: By Authority, 1889.

Price 3*d*.]

By Authority: JAMES C. BEAL, Government Printer, William street Brisbane.

1891.

QUEENSLAND.

COAL IN THE PARISH OF NOOSA.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Geological Survey Office,
Townsville, 9th December, 1890.

SIR,—I have the honour to forward herewith Mr. Rands' Report on Coal in the parish of Noosa.

I would point out that Mr. Rands identifies, without hesitation, the strata coming to the surface, over the whole area of the parish, as belonging to the Burrum Coal Measures. On this point Mr. Rands is well qualified to pronounce an opinion, as he has already mapped the Coalfield in what may be called the type area at Burrum, and traced its extension northward to the Burnett and southward to the Tiaro district. Its extension still further to the south, recorded in the present Report, makes the field almost co-terminous with the Ipswich Coalfield, and it is to be hoped that at no distant date the relations of the two fields will be definitely made out on stratigraphical as well as palæontological grounds.

Although the coal seams met with so far in the parish of Noosa are too much interrupted by "bands" to be serviceable, it is quite likely that better seams may yet be found, and it is satisfactory to learn from Mr. Rands that "there is every probability that if good coal is discovered it will extend undisturbed over a large area."

I have, &c.,
ROBERT L. JACK.

The parish of Noosa lies to the west of the Noosa River and Lake Cootharaba; and between Kin Kin Creek on the north, and the Six-mile and Cooroibah Creeks on the south.

The whole area is occupied by the Burrum beds, which are covered with a thick soil and dense scrub, and consequently very few sections were visible.

A discovery of coal was made a short time back in a gully some twenty chains to the south-west of the south-west corner peg of Canning's Selection No. 1176. The coal is about five miles, slightly north of east of Cooran Railway Station; and about one and a-half miles west of north of the "Nine-mile" waterhole on the Cooran and Noosa road. Mr. Goodchap has since taken up a Coal Prospecting Area of three-quarters of a mile square adjoining the south-west corner of Canning's selection.

The seam was first observed in a gully, running in a southerly direction into the Six-Mile Creek. A shaft was sunk on the western side of the gully to try it. This shaft, which is abandoned, and partly full of water, before reaching the coal passed through a soft friable sandstone, below which was a conglomerate containing pebbles of white quartz, and below that again black clay and shale. The seam of coal had a low angle of dip to the south-east. The coal in the waterhole was covered up with the mullock from the shaft.

A second shaft, which was in the process of sinking, is situated about 10 chains north-west of the above. It is 40 feet in depth, and is situated 41 feet east-south-east of a gully in which the coal was cropping out again.

The shaft passed through a coarse sandstone from the surface down to a depth of 22 feet; the sandstone gets finer and harder towards its base. Below the sandstone there is a seam of coal, with "bands," 9 feet 6 inches in thickness.

The "bands," unfortunately, are very numerous; there are 2 or 3 inches of coal, and then an inch or two of "band" (generally black or brown shale). The thickest coal without a band is 6 to 8 inches. The upper 3 feet or so of the seam is most free from bands. About 7 feet from the top of the seam there is a band of black shale 15 inches in thickness, and then 8 inches of solid coal.

The dip of the coal is towards the south-east, but was not distinct enough to be measured in the shaft. I took the level of the top of the coal in the gully, and in the shaft, which is 41 feet east-south-east; the coal in the shaft was 5 feet deeper than in the gully, giving a dip of 1 in 8, or 7 degrees. The true dip may be 8 or 9 degrees, but not more.

The coal is a dull-coloured bituminous coal, and very tender; in this latter respect it will probably improve at a depth. The Burrum coal seams, however, are not noted for their hardness. The

The worst point in connection with the seam is the number of bands it contains, and unless these become much fewer, or unite to form one or two thick bands, leaving the remainder clean, the seam will not be of any commercial value. The following is an analysis of a sample taken from some that was being sent to Brisbane; the sample was dried at 100 degrees C. before analysis:—

Fixed Carbon	69·1 per cent.
Volatile Hydrocarbons	21·4 „
Ash (white)	9·5 „
	100·0 „

The percentage of coke is 78·6. The coal swells up on coking, forming a light porous coke.

Two tons of this coal are being sent to Brisbane for trial, and three or four bags of it are to be tried on board the s.s. "Culgoa," running between Brisbane and Noosa.

Below this seam there is 11 feet of a hard black coaly shale, and then in the bottom of the shaft coal had just been struck again. The shaft had not gone more than three inches into it and the thickness is unknown. So far the coal is much harder than that in the upper seam: it is a bright bituminous coal; there were specks of iron pyrites on its facets. The analysis of this coal is very similar to that in the upper seam. The sample was dried at 100 degrees C.:

Fixed Carbon	66·9 per cent.
Volatile Hydrocarbons	21·6 „
Ash (yellowish)	11·5 „
	100·0 „

The percentage of coke is 78·4. The coal swells up on coking, forming a light porous coke, though somewhat denser than the coke from the upper seam.

I examined the gullies in the neighbourhood, with a view of following the strike of the coal, but owing to the dense scrub and thick soil with which the ground was covered, no sections were visible.

I spent two or three days going over the country between Kin Kin and the Six-Mile Creeks, and eastwards to Cootharabah and Tewantin, but scarcely any sections of the rocks were visible. Near the town of Coolathin, sandstones dipping south of east, crop out, and similar sandstones dipping in the same direction crop out at Boreen Point on the western side of Lake Cootharabah. About two miles west of Boreen Point, in Hatch's selection No. 252, sandstone and thin coal were cut in a shaft 25 feet in depth. The shaft passed through—

Surface Soil	0 to 8 feet.
Shales and Clay with streaks of Coal	8 to 21 „
Hard Sandstone	21 to 26 „

The strata are dipping a little south of east. Thin coal was also got near the surface on this selection in putting down post holes for fences.

No sections were visible in Kin Kin Creek, except near the heads.

The beds in this district appear to be dipping very regularly at a low angle to the south-east or thereabouts, and there is therefore every probability that if good coal is discovered it will extend undisturbed over a large area. It is, I believe, Mr. Goodchap's intention to continue with the sinking of the shaft in search of other seams, and to drive on the seam already discovered. A series of bore-holes in the direction of the dip would be a cheaper method of testing the ground.

WILLIAM H. RANDS,
Assistant Government Geologist.

Maryborough, 29th November, 1890.

To Robert L. Jack, Esq., Government Geologist.

Price 3d.]

By Authority: JAMES C. BEAL, Government Printer, William street, Brisbane.

1890.

QUEENSLAND.

PROPOSED BORING FOR WATER AT BRISBANE.

(REPORT ON, BY ROBERT L. JACK, GOVERNMENT GEOLOGIST.)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES AND WORKS.

THE success of boring operations in search of water in the Western interior of the Colony has suggested to the public mind the possibility of a solution of the difficulties resulting from an insufficient water supply for the metropolis in times of drought such as the present.

An idea prevails that all that is necessary to secure a supply of overflowing artesian water is to "go deep enough"; and so firmly is this idea fixed, that I may be excused for giving a short *résumé* of the circumstances under which water is present in the crust of the earth, with the view of showing that, except under certain conditions, no amount of perseverance or expenditure can attain the desired object.

In the first place, water occurs in chemical combination with many of the minerals which are among the constituents of the rocks forming the earth's crust. As, however, this water is not parted with, by natural means, except through the operation of processes too slow for human necessities, it may be disregarded for the present purpose.

In the second place, a proportion of the water falling in the form of rain penetrates gravelly or sandy superficial deposits, and, provided the latter rest on a comparatively impervious bottom, such as clay or close-grained rock, the water can be reached by shallow wells. Such supplies are, however, in the last degree unsuitable for cities, owing to the impossibility of preventing their contamination by sewage.

Thirdly, in the case of rocks, either covered by permeable superficial deposits, or not covered at all except by their own weathered debris, rain (whether falling directly on the rocks or conveyed to their surface by streams) will penetrate to depths which will vary with the openness of the rock in question.

There are few, even of the most compact rocks, which are not capable of being affected by "weathering" so as to admit of the percolation of water for some distance below the surface, and fissures may carry water to still greater depths.

In the case of a rock-mass incoherent enough to permit of the percolation of water between its component granules, the water will penetrate to depths varying with the spaces between the granules, by virtue of gravitation and capillary attraction. But friction will exert a retarding influence, and the rock itself at great depths will be rendered more compact by pressure, so that a lower limit to the percolation of water will be reached in all cases. Fissures may indeed occasionally provide a further passage for the water, but even fissures are not likely to remain open at great depths under the pressure of accumulated rock. Water will, therefore, be found to extend upward, from a nearly constant level to a more variable level—viz., that to which evaporation in periods of drought, aided by capillary attraction, can affect the underground store. It is a common experience in deep mining to penetrate, *first*, a belt in which the alternating accesses of water and air have produced weathering; *next*, a belt which is permanently wet (unless it be drained by the mining operations); and, *lastly*, a dry belt, where only care is required to keep back the water from the upper levels. Exceptions to this rule only occur where the reef or lode, or other fissures, present openings which form passages for water.

Water will rise above the level at which it is struck in a bore, provided its source or "head" is at a higher level. "Artesian water" does not, however, necessarily reach the surface and overflow. How far the water will rise depends entirely on the altitude of its source.

Two conditions are favourable to the discovery of artesian water. The first of these is the existence of fissures communicating with sources at higher levels, whether at the surface or in what may be called the "permanently wet" zone. The second is that in which permeable, porous, stratified rocks, such as sandstones, grits, or conglomerates, are covered by a lid of impermeable strata, such as shales, and the permeable strata crop out over a sufficient area to catch water enough to permit of their saturation, and where they dip into the earth's crust at angles high enough to overcome the resistance offered by friction. The effect of the circumstances combining to produce this latter condition will be much increased if the water in its progress should meet with an effectual rock-barrier, or with a stream of water gravitating from another source in consequence of an inversion of the dip of the stratum containing it.*

In

* Water may be forced to the surface in some cases by the expansive power of heat, but for the present purpose this condition may be disregarded.

In considering the question of the possibility of an artesian supply of water for Brisbane, I have found it necessary to give renewed attention to the geological structure of the whole district, to make traverses for many miles along lines radiating in every direction from the city, and to extend the lines drawn on the geological map issued by my colleague, Mr. Rands.

The first line to which attention may be directed is that denoting the boundary of the slates, schists, quartzites, &c., which occupy the site of the city proper. These rocks, although varying considerably in texture and composition, are *all*, so far as I have been able to see, compact, fine-grained, and practically water-tight, except in their weathered upper portions.* Surface water may, here and there, be obtained within the area embraced by this line—(1) in alluvial hollows, and (2) in the weathered upper portion of the rocks. No supply from such sources could, however, be drawn upon to any extent without becoming exhausted. Artesian water might even be obtained from some fissure in the slates, &c., but hundreds of bores might be put down without hitting upon such a happy chance. In short, I am reluctantly brought to the conclusion that, within the line referred to, there is no hope of a successful bore for artesian water.

A second line, supplied by Mr. J. B. Henderson, M.I.C.E., &c., Government Hydraulic Engineer, shows the limits within which water from the Enoggera and Gold Creek Reservoirs is supplied to the city.† Even if the area enclosed by this line were fully supplied in all seasons, the urgent necessity for a supply to the populous outlying districts is painfully obvious.

A third line shows the area occupied by the outcrop of a belt of ashy sandstone, which lies unconformably on the upturned edges of the slates, &c., and forms the base of the Ipswich coal measures. The permeability of this rock is not great, but on the other hand the rock is much intersected by fissures. The ashy sandstone is seen, to the north and south of the city, to dip under the Ipswich coal measures, but elsewhere it is divided from the latter by faults or fissures, and in other cases the coal measures are brought by greater displacements directly against the slates, &c.

It is only in the area occupied by the Ipswich coal measures that, in my opinion, any chance of striking artesian water is to be hoped for. A few suburban centres of population might reap material, if only temporary, benefits should bores in the Ipswich coal measures meet with success.

The chances open to the suburban localities north of the Brisbane River, situated within the area of the "Ipswich coal measures," are these :—

Rain falling on the area of granite or slates, &c., within the drainage basins of Breakfast Creek and Kedron Brook must, *so far as not evaporated or carried down to the sea*, find its way beneath, or into fissures in the ashy sandstone, and be retained by the underlying slates, &c., *or* flow over the surface of the ashy sandstone, to enter the first outcrop of permeable strata within the area of the Ipswich coal measures; *or* drain into the faults which frequently divide the outcrops of the slates, &c., from the Ipswich coal measures, and eventually find its way into permeable strata belonging to the latter series. The Ipswich coal measures present, in perfection, at least one of the necessary conditions for the storage of artesian water—viz., the alternation of permeable sandstones and conglomerates with impermeable shales. Unless the dip of the strata is such as to carry the water to localities where it can escape at lower levels, water may be expected to be found in deep bores. I see no reason to suspect leakage on a large scale from this cause. Unfortunately there are not many sections to show the dip of the strata, but the North Coast Railway exposes several dips *towards* the south, so that it is at least *probable* that a supply of water may be tapped. For the first experiment, I should recommend a bore in the north-east corner of the Racecourse. Whether the water will rise quite to the surface will depend on where it enters into the strata of the Ipswich coal measures, but, owing to accumulations of alluvial drifts, and the depths to which the coal measures are themselves weathered, no precise evidence can be obtained on this point. Whether it is desirable to obtain water in the position indicated is a question upon which the Hydraulic Engineer can advise the Government and the local authorities.

The nearest place south of the city in which, from the disposition of the strata of the coal measures, I could recommend boring is in the little reserve at the junction of the Ipswich and Logan roads, three miles south of the Dry Dock. This locality is, apparently, in a trough, on one side of which the strata rise to the north till they overlie, or abut against, the slates, &c., and on the other side of which the strata rise to the south-east till they abut (near Kingston) against slates and quartzites. In this bore I do not anticipate that the water will rise quite to the surface, as the outcrops of the lowest strata of the coal measures into which water might percolate are little, if at all, higher than the site of the bore.

It is probable that contracts would be obtained on better terms for two bores than for one. Should the bores prove successful, others might be put down where required, *within the area of the Ipswich coal measures*, as, for instance, at Oxley, or the mouth of Bulimba Creek, or wherever population becomes sufficiently concentrated; *providing always* that the necessity for local supplies has not been done away with by the adoption of a comprehensive gravitation system for the whole district.

In all cases bores should be stopped whenever the slates, &c., are met with, as, except in the extremely unlikely event of striking an open fissure, a supply of water is not to be hoped for in these rocks.

ROBERT L. JACK.

Department of Mines,
Brisbane, 5th March, 1889.

Department

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* It is true that some beds of conglomerate are met with, but the pebbles are enclosed in a practically water-tight matrix.

† Brought up to January, 1888, and not much altered since that date.

Department of Mines,
Brisbane, 12th March, 1889.

Sir,—Referring to our conversation on the subject of the depth at which water may be struck in the proposed bores near Brisbane, I may as well put in writing the substance of what I told you.

If the strata of the Ipswich coal measures were geologically mapped in detail, an answer to the question might be given with some degree of confidence. That such geological mapping is highly desirable for the purpose you have in view, and for other economic purposes, is a proposition to which I daresay you will agree; but before the whole of the Ipswich beds could be so mapped two or three seasons of drought might have come and gone. Mapping of this sort, I may mention, is done in England by an expert geologist at the rate of about 100 square miles per annum, and all waste of the geologist's time in mensuration or location is spared him by the use of the almost perfect Ordnance maps.

In the circumstances of the Colony, boring in search of artesian water necessarily involves an element of chance, or, properly speaking, the data for calculating the depth at which water may be struck have not yet been collected. I should, however, advise that a maximum depth, say 3,000 feet, should be fixed upon, and bores which have attained that depth without striking water should be abandoned. (Bores should of course be stopped earlier if the slates, &c., are struck.)

I have seen reason to believe that not only is the base of the Ipswich coal measures thrown down in many places to a considerable depth by faults at the (surface) junction of these rocks with the older slates, &c., but also that faults traverse the coal measures themselves, with the effect of throwing the base of the coal measures to still greater depths. But for this consideration I should not have recommended boring so near the city.

I have, &c.,

ROBERT L. JACK.

J. B. Henderson, Esq., M.I.C.E., Hydraulic Engineer.

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1891.

QUEENSLAND.

TIN MINES NEAR COOKTOWN.

(SECOND REPORT BY ROBERT L. JACK, GOVERNMENT GEOLOGIST, ON THE)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

NEARLY four years ago I visited and reported* on the tin mines near Cooktown, then in their infancy. Stream tin was being obtained in almost every gully from Mount Romeo to Mount Amos, but lode mining had just commenced on the slopes of Mount Amos. Since that date the alluvial mining has gone on steadily. The quantities of ore raised, according to the Annual Reports of the Department of Mines, have been as follows:—

1885	...	...	...	...	...	...	...	300 tons
1886	...	...	...	...	...	...	...	148 „
1887	...	...	...	...	...	...	...	945 „
1888	...	...	...	...	...	...	...	1,051 „
1889	...	...	...	...	...	...	...	690 „

The greater part of the above must have been stream tin, with the exception of 49 tons crushed at the Lion's Den in the years 1889 and 1890 and a like amount from other lode mines, but it must be remembered that the Lion's Den machine is the only one yet at work. A considerable number of men are still engaged streaming in the gullies, especially during the wet season, but shallow stanniferous wash is less easy to obtain than it used to be, so that the remark is frequently heard in the district that the alluvial tin has been nearly worked out. This seems to me a very hasty conclusion, as the deep and extensive alluvial flats of the Annan River, and its tributaries Wallaby, Mongumby, and Trevethan Creeks, which may yet rival Stanthorpe, are still absolutely untouched.

The general geological features of the district are indicated in the report above referred to, and further details will be found in the following pages and in the Geological Sketch Map (No. 1) herewith. With the exception of the granitic mass at Cooktown, the whole of the coast line (which I had an excellent opportunity of observing from the steamer, and which I also visited near Mount Amos) appears to be constructed of slates and micaceous talcose and chloritic schists.

The observations on the lode mines herein recorded were made in the latter half of November last, in company with Mr. Joseph Shakespeare, Inspector of Mines, who rendered me valuable assistance when his own official duties permitted. A number of samples were brought away and assayed by Messrs. Coane and Clarke of Charters Towers.

It may be said of the field generally that the true fissure-lode character of the mines has now been tstablished beyond dispute, the evidence of the insignificant openings at Mount Amos seen in 1887 having eow been supplemented by the more extensive workings in that locality as well as on the Table-land and in nhe Mount Leswell and Collingwood Districts.

MOUNT LESWELL.

The Mount Leswell Mines are situated on a spur between two gullies which drain into Baird's Creek, a tributary of the right bank of the Annan. The altitude of the mines is about 1,000 feet above the level of the sea. The mines comprise Leases Numbers 22, 28, 51 and 52. The sketch plan on sheet 2 shows the Mount Leswell and adjoining leases.

From the Mount Leswell Public-House, which stands between Baird's Creek and the Annan, the country rock in the valley, and up the spur to near the mines, is of greywackes and quartzites. These are succeeded near the mine by granite composed of clear white orthoclase felspar, black mica (biotite), and quartz (specimen No. 53), which continues across the divide to the waters of Jones's Creek, a tributary of Wallaby Creek. The granite of Mount Leswell, so far as mining operations have gone, is generally soft and incoherent, although occasionally hard boulders are met with, and similar boulders bestrew the surface in all directions.

No. 1 shaft is on the crown of the ridge near the house of the manager, Mr. William Pascoe. Down this shaft, from the 18 to the 52-feet level, decomposing granite is met with. The level has been driven from No. 1 shaft to No. 5 shaft (which latter is timbered so that no section can be seen), a distance

* "Geological Observations in the North of Queensland 1886-7."—Brisbane: By Authority, 1887.

distance of 70 feet north 12 degrees west. For 45 feet the level is carried through soft decomposing coarse grey granite containing angular "nests" of tourmaline. At 45 feet, what is known as the "Eastern Lode" is met with. The course of this lode is north-west, and its underlie north-east. The lode is about 8 feet wide, both its hanging and foot-wall sides having a good deal of soft decomposed felspar, while the hanging wall has also a good deal of quartz, but the central part is nearly pure tourmaline. I got some prospects of tin, but by no means rich ones, from this lode. From the lode to No. 5 shaft the level again traverses soft granite. I selected samples of black tourmaline (Nos. 34, 35 and 36) from the lode at 52 feet, 55 feet, and 58 feet respectively from the centre of No. 1 shaft (all from the floor of the level), and these all yielded on assay "traces" of tin.

Eighteen feet from No. 1 shaft a crosscut is carried to the east of the level. After 12 feet of soft granite the crosscut encounters a vein of black tourmaline and quartz, varying from 1 to 3 feet in thickness, and underlying at a high angle to the north-east. There is little doubt that this vein represents the "Eastern Lode" seen in the main level, as the crosscut is carried for 68 feet further to the east without meeting with anything but granite. Specimen No. 37 (black tourmaline), taken from the floor of the crosscut 14 feet from the level, yielded, on assay, "traces" of tin.

In the uppermost 18 feet of No. 1 shaft a mass of tourmaline is seen crossing the shaft from south 30 degrees west to north 30 degrees east, the granite being seen only on its south-eastern side. A chamber, about 15 feet long by 5 feet wide and 6 feet high, has been opened on this tourmaline mass on the north side of the shaft. The western side of the chamber shows quartz with only long needles of tourmaline. Over head and under foot the tourmaline is nearly solid, although it is interrupted by a "horse" of decomposing granite at the western end of the chamber. The northern wall of the chamber is mostly of soft granite, with a few crystals of tourmaline, but the granite passes upwards and downwards into nearly solid tourmaline. In tourmaline rock, near the bottom of this wall, a good deal of tin ore is visible, and some samples crushed and washed gave very rich prospects. As tin ore is not easily seen in rock of this character, I selected three samples for assay. No. 31 (black tourmaline showing a little tin ore) was taken 18 feet from the centre of the shaft, and 1 foot above the floor of the chamber. It yielded 21·7 per cent. of metallic tin on assay. Sample No. 32, taken 3 feet north-east of No. 31, and sample No. 33 from the centre of the floor of the chamber (both tourmaline and quartz), yielded only "traces" of tin.

A somewhat sinuous drive at the same (52 feet) level connects No. 1 shaft with the "old ladder shaft," a distance of 38 feet, on a course of west 20 degrees north. The "ladder shaft" is a little further down hill than No. 1 shaft, and its depth to the 52 feet level in No. 1 shaft is about 45 feet. In this rive, a few feet south-south-west of No. 1 shaft, a lode is cut, which may be connected with the mass of tourmaline, &c., seen in the chamber at the 18 feet level south of No. 1 shaft, but looks like an independent "pipe" traversing the granite country, and appears as if it would thin out not far above the roof of the drive. It is followed downward in a winze, on an underlie of about 70 degrees to a depth of 28 feet below the level (*i.e.*, to the bottom of No. 1 shaft). Sample No. 38 (tourmaline and quartz, showing a few specks of tin ore), from the top of the winze, yielded on assay 0·343 per cent. of metallic tin. Sample No 39 (tourmaline and quartz), from the end of the winze furthest from No. 1 shaft, and 5 feet below the level, yielded only "traces" of tin on assay.

Along the drive, towards the old ladder shaft, this tourmaline lode varies from 1 to 4 feet in thickness, but in one place is only represented by a thin streak or vein on the roof. Sample No. 40 (tourmaline and quartz) from this lode, 30 feet from No. 1 shaft (the nearest point to the ladder shaft where the lode is seen), yielded "traces" of tin.

At the mouth of No. 1 shaft lies a heap of ore of good quality, roughly measuring 720 cubic feet. It is impossible to say how much of this ore came from the "Eastern Lode," how much from the "chamber," and how much from the winze and the drive from No. 1 shaft to the old ladder shaft. Two specimens (Nos. 6 and 7) were taken from the heap, the first being nearly pure brown cassiterite with a little tourmaline, and the second a mass of needles of tourmaline in which only a little tin ore is visible, but which from its high specific gravity must contain a fair proportion.

An open cutting, commencing about 24 feet below the level of the mouth of No. 1 shaft, skims the surface of the hill from south 37 degrees west towards No. 1 shaft for a distance of about 97 feet. Commencing at the lower end of the cutting, surface wash is seen for the first 18 feet, and for 18 feet further decomposed granite is met with. Next comes a nearly vertical wall of milk-white quartz traversed by long needle-like crystals of tourmaline which are often broken and twisted (specimen No. 5). The dividing line of the quartz and granite runs north-west and south-east. In two feet the tourmaline-bearing quartz merges into nearly solid tourmaline, with which only a little quartz is mixed up. A shaft, 10 feet long, 10 feet deep, and 3 feet wide, has been sunk on the tourmaline below the floor of the cutting. Above the shaft the walls of the cutting show about 7 feet of solid tourmaline and quartz. From the north-eastern end of the shaft the cutting has been carried up the hill (towards No. 1 shaft) for a distance of about 20 feet in lode-matter consisting entirely of tourmaline, with the exception of two "pipes" of quartz with a little talc and tourmaline. This portion of the cutting averages 8 feet wide and 2 feet deep. In it tin ore can be seen almost anywhere on careful examination. In one place, between the 10-feet shaft and No. 1 shaft, and about 12 feet from the former, the tin ore for about 18 inches vertical by 2 to 3 inches horizontal bears a proportion to the tourmaline, which may be roughly estimated as 3 to 1. Ten tons of ore from this cutting, sent to England about two years ago, are said to have yielded 15·7 per cent. of tin ore. A stack of ore, containing roughly about 162 cubic feet, shows tin ore pretty freely. The ore is, however, difficult to see, the mass having been reduced by weathering to a heap of tourmaline debris with only a few solid pieces of a few cubic inches. Samples from the heap gave a very good prospect of tin ore on being washed and crushed.

Whatever doubt there may be as to the relations of the different masses of ore met with in and near No. 1 shaft and the open cutting, there can be no doubt of the extension of a continuous lode from No. 1 shaft through Nos. 2 and 3 to No. 4 shaft. No. 2 shaft commences at a level a little lower than the top of No. 1, and 74 feet distant, north 35 degrees west. The two shafts are almost connected by open-cast work carried to an average depth of about 15 feet. A heap of ore from this open-cast, measuring roughly 450 cubic feet, consists for the most part of black tourmaline, some of it showing cassiterite pretty

pretty freely. Blocks can easily be obtained containing 25 per cent. of tin ore. There is evidently a good deal of tin ore in the heap, although the quantity could not be estimated, as the tourmaline had crumbled away like so much old coal slack.

No. 2 shaft is 50 feet deep. At the depth of 35 feet a level has been driven on the "Western Lode" to north 35 degrees west, connecting No. 2 with No. 3 and 4 shafts. The lode underlies to east 35 degrees north at a high angle. At No. 2 shaft it is over 2 feet in thickness and can be seen in the shaft from the level nearly to the surface, the country being soft granite.

No. 3 shaft is 42 feet deep, and commences a little lower down the hill than No. 2, from which it is 23 feet distant.

No. 4 shaft cuts the level at 20 feet, and the tunnel afterwards referred to at 66 feet. It is 34 feet north 35 degrees west of No. 3 shaft.

Along the level from No. 2 shaft to No. 4 shaft the lode is continuous and over 2 feet in thickness. On the foot-wall are generally about 6 inches, mainly of quartz, the remainder being tourmaline. The following is a list of specimens taken from this level, with their assay values for tin ore, the specimens having been taken at regular intervals, without reference to their supposed richness or poorness, the tin ore being difficult to see in the tourmaline matrix:—

No. 41.—South end of No. 2 shaft, 8 feet above level. (Tourmaline, high specific gravity but no visible tin ore.) 5·9 per cent. metallic tin.

No. 42.—Floor of level, 8 feet from centre of shaft No. 2. (Tourmaline; no visible tin ore.) 10·4 per cent. metallic tin.

No. 43.—Level 15 feet from centre of shaft No. 2, two feet above floor. (Coarse tourmaline with flakes of quartz; a good deal of tin ore visible.) 15·7 per cent. metallic tin.

No. 44.—Across the lode in level at No. 3 shaft. (Tourmaline.) Traces of tin.

No. 45.—In level 10 feet from No. 3 shaft (towards No. 4 shaft) across the lode. (Tourmaline and quartz.) "Traces" of tin.

No. 46.—In level 20 feet from No. 3 shaft, across the lode. (Coarse tourmaline with quartz and a little visible tin ore.) 1·3 per cent. metallic tin.

No. 47.—Thirty feet from No. 3 shaft across the lode. (Tourmaline and quartz, with a little visible tin ore.) 0·44 per cent. metallic tin.

No. 48.—South end of No. 4 shaft at level. (Tourmaline and quartz; no visible tin ore.) 2·44 per cent. metallic tin.

No. 49.—North end of No. 4 shaft at level. (Mostly quartz). "Traces" of tin.

The lode can be seen in No. 4 shaft down to the level of the tunnel.

A tunnel has been driven from the left bank of the gully on the north side of the ridge to south 30 degrees east, cutting No. 4 shaft 53 feet from its mouth. It is intended to remove the ore from the mouth of this tunnel by a tramway. Where the tunnel cuts the lode at No. 4 shaft the lode is from 6 inches to 10 inches thick, and is about half quartz, the quartz predominating on the foot-wall side. At the face of the tunnel (a little beyond No. 4 shaft) the lode is somewhat pinched and broken. Sample No. 50, from the face (tourmaline and quartz) gave, on assay, "traces" of tin.

Sample No. 5 (tourmaline and quartz) from No. 4 shaft, 5 feet above the roof of the tunnel, gave "traces" of tin on assay.

A second tunnel 25 feet above the level of the first, and commencing about 1 chain to the east, exposes, near its mouth, a very large lode of coarse tourmaline crystals, in which the manager informed me no tin ore has yet been discovered. This lode appears to run south-east. The tunnel is continued to near the No. 5 shaft, where there is a large lode of tourmaline. Specimen No. 52, taken from the face of this tunnel, showed tourmaline with a fair proportion of tin ore, and assayed 6·84 per cent. of metallic tin.

It appears from the sampling and assaying that "pay ore" has not only been met with in the Western Lode at higher levels, but is also touched in the 35-feet level, without one failure, in three places (selected without any previous knowledge of the mine or visible difference in the character of the stone)—one at the south end of No. 2 shaft, one 8 feet north of the centre of the shaft, and one 15 feet from the shaft—say, over 20 feet along the level. All along the level every sample taken contains at least "traces" of tin ore, and at No. 4 shaft an assay of stuff containing no tin ore visible to the naked eye gives 2·44 per cent. of metallic tin. About 20 feet below the level the "second tunnel" affords a sample assaying 6·8 per cent.

WHEAL DAVEY.

The Wheal Davey Mine is comprised in Lease 58, to the south-east of Mount Leswell, and on the same spur, but probably at an altitude lower by about 500 feet. The country rock is soft granite, similar to that of Mount Leswell, The cap of the lode can be seen down the hill about 1 chain south of the eastern shaft. It shows large masses of quartz, and also of coarse-grained tourmaline, crystals of cassiterite being frequently visible on joints and faces. Two shafts have been sunk, about 20 feet apart, on an east and west line, both about 40 feet in depth, and connected by a level near the bottom. The level, however, was so full of water that I could only obtain, with some difficulty, a glimpse of the roof.

In the eastern shaft, near the bottom, I could see a large lode underlying to the west at a low angle. Sample No. 54 was taken from the roof of the level near the eastern shaft, and was pretty nearly the only specimen I could reach. It consisted of coarsely crystalline tourmaline, which on being crushed and washed gave no prospect of tin ore, but gave a trace on assay. A heap of stone containing roughly 90 cubic feet, lying at the mouth of the eastern shaft, consisted of tourmaline (without quartz), showing a good deal of pale-brown cassiterite. Judging from its specific gravity and the amount of tin ore visible, I should say that the heap would be payable. Sample No. 55 (a mass of fine needles of tourmaline with visible tin ore), taken from this heap, assayed 6·8 per cent. of metallic tin. At the western shaft a heap of ore of similar character had a somewhat higher specific gravity, although less tin ore was visible; it measured about 60 cubic feet. Sample 56, taken from this heap, consisted of long light-brown tourmaline crystals, and was the only coloured example of that mineral which I saw on the field.

MOUNT HARBORD.

Mount Harbord adjoins the Wheal Davey on the west, lower down on the same spur. The country rock is a chloritic greywacke. Owing to the state of the two shafts, which, having been disused for eighteen months were judged to be unsafe, not much can be said about the mine. The lode appears to run north-north-west. The two shafts are about half-a-chain apart. The northmost shows a lode underlying to the east near the surface, and to the west at a lower depth. The southmost shaft is said to be over 70 feet deep. Tin ore and tourmaline can be seen in a heap, apparently stacked for crushing, near this shaft, but a considerable proportion of the heap consists of greywacke.

COLLINGWOOD.

The Collingwood is a 30-acre lease (No. 81), on the opposite or eastern side of the Mount Leswell range from the Mount Leswell group of mines. The western boundary of the lease drains into Baird's Creek, but the greater part of the area is drained by a gully which falls into Jones's Creek, a tributary of Wallaby Creek. In the absence of surveys of the leases adjoining the Collingwood itself, the sketch plan on sheet 3 prepared by Mr. Dodd, manager of Collingwood, may serve to show the approximate positions of the adjoining leases and claims.

A drive to the north-west, in the bed of a gully near the eastern edge of the Lease, shows soft decomposing fine-grained granite with yellow crystals of felspar, fine scales of mica and blebs of quartz, succeeded up the gully by quartz with tourmaline and tin ore. The latter appears to run north and south, as exposed in the bed of the gully, and to be at least 12 yards in width.

Two chains north of the gully, No. 3 shaft has been sunk to a vertical depth of 49 feet. No. 2 shaft is 33 feet 8 inches north-east of No. 3, and 35 feet deep. No. 4 shaft is 95 feet north, 25 degrees west of No. 2. No. 1 shaft is 70 feet south-east of No. 2.

No. 4 shaft is 36 feet in vertical depth, and from the bottom a drive has been carried 37 feet to the west. Down the shaft to near the level of the drive are soft decomposed greywackes, with veins of decomposing granite, which rise, on the whole, at low angles towards the shaft and sink beneath the face of the drive. Below the granite veins is a mass of quartz and very fine-grained tourmaline, forming possibly a nearly flat lode. This lode shows everywhere a little tin ore, which is fairly rich in a small underhand stope a few feet west of the shaft. I took two specimens from this drive. No. 21 (selected by the manager), from 17 feet west of the shaft just beyond the underhand stope, yielded 1·26 per cent. of metallic tin on assay. No. 22, from the floor of the drive, 31 feet west of the shaft, gave a "trace" of tin. The same drive is carried 25 feet east of the shaft. In this portion of the drive a vein of granite, with tin ore and tourmaline underlying it, sinks under foot. Near the eastern face a soft decomposing granite vein comes in with a feather edge and thickens towards the face. Beneath it is a fine-grained talc rock containing much fine tourmaline. Sample No. 3 from the latter gave on assay 1·3 per cent. of metallic tin. All the stone which has been stacked (about two tons) has come from the underhand stope. It shows tin ore, which may be estimated to amount to about 5 per cent. by bulk.

No. 2 shaft is 35 feet deep, and shows, from near the surface, soft decomposing granite mixed with soft decomposing talc rock, and quartz and tourmaline rock. A drive has been carried from the bottom to No. 3 shaft and for 21 feet beyond. No. 3 shaft is 49 feet deep (the surface being a little higher than at No. 2 shaft), and its bottom is a little below the level of the drive. A sample (No. 4) from the bottom gave a very fine prospect. The shaft is sunk through a rock composed of coarsely-crystalline felted talc with a little fine thready tourmaline and more or less tin ore throughout, with a little pyrites and arsenical pyrites. From No. 2 shaft towards No. 3 the drive cuts through soft coarse-grained talc rock, in which tin ore can be seen, generally in coarse spots, and sometimes occurring as large crystals in veins associated with quartz. From this drive specimens 24 and 25 were selected by Mr. Dodd 6 feet south-west of the centre of No. 2 shaft and three feet above the floor of the level. No. 24 gave "traces" of tin only. No. 25 gave 0·7 per cent. of metallic tin. Specimens 26 to 28 were taken by myself without reference to the supposed tin contents. No. 26, from 15 feet south-west of the shaft and 3 feet above the floor, yielded on assay 5·5 per cent. of metallic tin. No. 27, 20 feet from the shaft and one foot above the floor, gave 9·4 per cent. of metallic tin. No. 28, 25 feet from the shaft and three feet above the floor, gave 19·4 per cent. of metallic tin. From the heap raised from this drive I took one sample (No. 2), not apparently specially rich, and it gave a very good prospect of tin ore. I should say that the whole would pay to crush, while undoubtedly rich patches would swell the average yield.

The drive to the south-west of shaft No. 3 shows talc rock, becoming gradually tougher and finer towards the face, and carrying a little visible cassiterite all the way to near the face, where a nearly vertical vein of quartz and decomposing arsenical pyrites is met with. A similar rock extends beyond this vein, but the manager informed me that the drillings from a hole 3 feet deep gave no prospect of tin. In spite of this, however, I see no reason to think that the limit of the tin-bearing rock has been reached in this direction.

The drive has been carried back for 16 feet to the north-east of No. 2 shaft. At the face is a 5 feet vein of fine-grained black quartz and tourmaline. Sample No. 3 from this vein gave a very fair prospect of tin.

No. 1 shaft is 40 feet deep, and commences, perhaps, 20 feet below the level of No. 3 shaft. In the ladder way, a little west of the shaft, there is a dark quartz with tourmaline carrying tin ore. This is cut again in the well-hole at the bottom of the shaft, showing the deposit to have an underlie to the east. A drive 19 feet to the south from the bottom of the shaft shows granite with veins of tourmaline and quartz underlying at 45 degrees to the south. These veins often show some tin ore. There is a good deal of pyrites on and near joints in fine-grained granite beneath the veins. Samples 29 and 30 were taken haphazard from the face of this drive, and both gave on assay "traces" of tin.

Another drive 24 feet in length to the east from the bottom of the shaft shows hard granite (specimen No. 1) pierced by a 10 to 20 inch vertical vein of soft granite. Near this are veins of dark tourmaline and quartz, with some tin ore in rather large crystalline masses.

LEASE 96.

This is a 10-acre lease north of the Collingwood, on Mulligan's Gully, a tributary which falls into the left bank of Jones's Creek and the ridges south of the gully.

On the top of a ridge an opening 12 feet long by 6 feet deep shows blocks of a hard rock composed of felspar, quartz, and tourmaline, with tin ore. Sometimes the tourmaline is massed pretty closely together, and rich in tin. A good deal of tin in the solid rock seems to be present in payable proportion. The solid blocks are surrounded by decomposing rock, but apparently point to a lode running north and south (specimen No. 10).

A shaft has been sunk to a depth of 43 feet about one chain south of the opening above referred to. The bottom of the shaft shows quartzite 6 feet wide (in horizontal beds?) with vertical streaks and veins showing tin ore, pyrites, and a little tourmaline, striking north-north-west. (Specimen No. 11.)

Within the limits of the lease there are four or five other openings on "lodes" or deposits like the first above referred to. From some of these, rich specimens have been obtained.

DODD'S LODE CLAIM.

This claim lies a short distance north of Lease 96, near the head of Byers' Gully, which is a tributary of Jones's Creek.

An opening near the head of the gully shows large blocks of talcose and chloritic greywacke, in which groups of small crystals of cassiterite can be seen. The blocks measure up to one cubic yard, and cross the gully from north 15 degrees west to south 15 degrees east, but I could not be certain that they were *in situ*. The adjacent rocks are greywackes and shales. Stream tin occurs in the gully below this point.

About 1 chain further down the gully a width of at least 20 feet of the surface of the rock has been laid bare by workings. The rock is of sedimentary origin, and varies from a rather coarse-grained quartzite to a rock in which talc and chlorite predominate over the siliceous material. Fine crystals of cassiterite are scattered throughout the rock, sometimes in "nests" or blotches, and sometimes forming veins. Secondary quartz is generally plentiful where the tin ore is visible. There is also a little fine-grained tourmaline, and a good deal of arsenical pyrites. There is some payable stone; but the difficulty is, in the absence of machinery, to follow or isolate it. (Specimens 8 and 9.)

CAHILL BROTHERS' LEASE—(No. 89).

This lease lies between Lease 96 and Jones's Creek. The principal working is on a lode which is distinctly traceable at the surface from the shaft for two chains north 12 degrees west to a gully. The shaft at the southern end of this line is 56 feet deep. The lode pinches down the shaft, and about 10 feet from the bottom is a mere thread, but it opens out in the lowest 10 feet of the shaft to 2 feet in thickness. At the top of this bulge there is much quartz and tourmaline, and only a little tin ore; but the lower portion of the bulge yielded a large quantity of very rich tin ore. The stone raised consists of quartz, tourmaline, and tin ore—sometimes very little quartz. Much of this stone is at least half tin ore by bulk. The cassiterite is pale-brown in colour, and occurs in large masses. Examples were observed of cassiterite crystals pierced, as it were, by arrows of tourmaline. (Specimens Nos. 16 and 17.)

From higher levels in the shaft there appears to have been more quartz in proportion to tourmaline, and the cassiterite (which is very pale in colour) is more disposed in regular veins (specimens 18, 19, and 20). The country is granite of the ordinary type. Near the bottom of the shaft the lode is confined between distinct and nearly vertical walls.

In the gully, 2 chains north 12 degrees west of the shaft, the lode is exposed in a small opening, where it is seen to be from 1 to 2 feet in thickness. It is here more quartzose than at the shaft, the quartz being ribboned with vertical veins showing tin ore and arsenical pyrites.

In the same lease, on the head of a gully, about 150 feet south-east of the shaft, an opening 10 feet by 6 feet has been made to the depth of 5 feet on a second lode, which is vertical and runs north-north-west. The cap of the lode shows solid blocks, up to 2 feet in width, of a rock having a sort of porphyritic appearance, with a matrix of quartz and blotches of tourmaline and cassiterite.

In a shallow shaft about 3 chains south-east of the last opening a third lode is met with, its cap showing a good deal of tin ore and decomposing arsenical pyrites in a matrix of tourmaline and quartz. The lode is nearly vertical. It was followed in the shaft for 30 feet, when it thinned out to a narrow vein.

RICHMOND.

The Richmond Claim is on the right bank of Jones's Creek, south-south-east of lease No. 89 and north-east of the Collingwood. Very little work has yet been done, so that only the superficial aspect of the lodes can be described.

On a rise between two gullies the cap of a vertical lode, from 1 to 3 feet in thickness, is seen running north-north-west. It shows large masses of black tourmaline in a matrix of felspar, and contains a considerable proportion of tin ore, sometimes very rich.

From the cap of a lode east of the last, and further down the hill, about 2 tons of very rich specimens mixed with tourmaline have been taken (specimen No. 12). This lode also runs north-north-west, and varies from 10 inches to 2 feet in thickness. There was a rich bunch at the surface, but beneath it in a shaft 6 feet deep the stone carried only "prospects" of tin ore. At the south end of the shaft the lode appears to die out.

A third lode is seen about 1½ chains south-east of the first. It is apparently vertical, and from 6 to 18 inches in width. Its cap shows felspar, tourmaline, and tin ore.

LION'S DEN.

The Lion's Den group of mines is situated on the head waters of Mongumby Creek, which falls into the right bank of the Annan about two miles north of the junction of Wallaby Creek and the river. A dray-road leads from Platt's Public-House, near the mouth of Mongumby Creek, and follows the creek up

up on its right bank to Robbins' slaughter-yards, a distance of about three miles. At this point the road commences to ascend the range by a very steep grade, and the mines are reached in about one mile more. The topmost mines are situated on the crown of a spur of the so-called "Tableland," at an elevation of about 1,760 feet above the sea. The ore-dressing machinery is on the left bank of Byers' Creek (one of the heads of Mongumby Creek) at an elevation of about 560 feet lower (see plan on sheet 2).

The road from Platt's to Robbins' apparently traverses a country rock of slate and schist, although owing to the accumulation of alluvial deposits the bed-rock is rarely seen. In ascending the range the road crosses micaceous grey slates and greywackes. Where the road crosses Byers' Creek, about 400 yards below the machine, altered coarse-grained quartzites are seen. From this point up the spur to the mines the country-rock is a peculiar granite in which schorl apparently takes the place of mica, although it is not regularly distributed throughout the felspathic and quartzose matrix, but has a tendency to be grouped together in "nests," which on weathered surfaces present the appearance of pebbles in a conglomerate.

Shaft A, on the crown of the ridge near the south-east corner of Lease 43, is 60 feet deep. I found that it had been timbered to the 30-feet level, and consequently I could see nothing of the lode; but the manager informed me that the latter was followed in the shaft to the depth of 29 feet, when it went out of the shaft having a slight underlie to the south-west. At 30 feet a level connects shaft A with shaft B, the horizontal distance being 97 feet. In this level the country rock (of granite, such as is described above) can be seen on both sides. The bearing of the level is north 8 degrees west (magnetic). The ground has been stoped out from the level to the surface, the ore, according to the manager, having been carried by a soft "porphyry" intersecting the granite. Twenty feet north of shaft B in this level a branch lode left the main lode on a course slightly more to the west, while the main lode continued up to the surface. Fifty-seven feet beyond shaft B a pass goes up to the surface from the level (12 feet), and down the underlie of the lode to a level 30 feet beneath. Seven feet beyond the pass (3 feet short of the face) I saw a decomposing felsite or porphyry, 9 inches in thickness, about half its mass being composed of tourmaline with some tin ore. About 15 feet back along the level from the pass I obtained from the floor some specimens of soft "porphyry" spotted with fine crystals of cassiterite. Specimen No. 57 yielded, on assay, 5·4 per cent., and Specimen No. 58, 11·4 per cent. of metallic tin. It may be mentioned that the specimens bear a great resemblance to some specimens from the "White Face" at Mount Bischoff in the Geological Survey Museum.

These two were the only places where the tin-bearing stone could be seen in the level, the ground above being for the most part stoped out.

The 60-feet level, extending from shaft A through shaft B, has been carried to a total distance of about 370 feet from shaft A. This level will be referred to under the head "No. 1 Tunnel." Shaft B has been sunk to the 60-feet level of shaft A.

The lode can be traced as a streak on the surface for some distance down the hill to the north. The "porphyry" of the lode is a mass of decomposed felstone, with fine quartz blebs and lumps of tourmaline weathering out like pebbles. Between shaft B and Byers' Creek the extensive open workings Nos. 3 and 4 occasionally show on the faces a little tin ore, which seems to occur by preference among "nests" of tourmaline, and on joints (which latter generally underlie south at 45 degrees) in the neighbourhood of a fissure in the line of the lode worked in the levels in connection with shafts A and B. The country rock here is granitic, but the biotite has mostly decomposed, and is frequently replaced by schorl.

In the open working, known as No. 1 Platform (near the southern boundary of Lease 26), a mass of tourmaline varying from 2 inches to 5 feet in thickness furnished the great body of rich ore first obtained from the Lion's Den. It ran nearly north and south. Joint planes in the same line show crystals of cassiterite and tourmaline. No. 1 Tunnel, starting from this platform, runs south-east, and at 176 feet cuts the lode A B at the 60-feet level, 34 feet north of shaft B. From the point where the tunnel cuts the lode southward to shaft A the lode has been stoped out above the level. In consequence I could see nothing of the lode, except under foot at its intersection by the tunnel, where I saw some good ore dug out from beneath the rails. Specimen 61 from this place gave, on assay, 10·78 per cent. of metallic tin.

Along the level (=60-feet level of shaft A and B) north of its intersection by the tunnel for 20 feet, the lode is 4 feet wide, and has been worked out above the level. Twenty feet north of the tunnel a winze has been sunk 44 feet deep; but owing to the accumulation of water I could not see the bottom, where the lode is said to be nearly a foot in thickness. At the northern face of the level the lode is pinched in hard ground to a mere joint-plane. On this level the manager reports "that nearly all the tin stone has been stoped out from the level to the surface, and that the quality of the stone has varied considerably, some very rich bunches having been opened up, while other patches have been of a less valuable nature, and portions very poor or altogether barren. Its richness varies from 2 to 3 per cent. to 20 per cent. oxide or even more. The width of the lode also varies considerably, sometimes running to a mere thread, and at other times opening out to 4 or 5 feet, but always retaining its character as a well defined fissure lode."

From "No. 2 Platform," which is nearly on the same level as No. 1, and situated near the north-east corner of Lease 43, No. 2 Tunnel has been driven to south 16 degrees west. At 260 feet it cut the lode A B 77 feet north 8 degrees west of shaft A.

The ore-dressing plant consists of—

A giant rock breaker 9 inches by 15 inches.
Two sets of Walls' Cyclone Rolls, each 14 inches by 16 inches, with automatic ore-feeders.
A Revolving Sizing Trommel and automatic link-belt Elevator, with buckets.
Two Revolving Trommels with screens.
Three sets of Jigs.
Two Frue Vanners.

Little handling is required in the machine-house, the working of the machinery being mainly automatic. The machinery is driven by a 6-feet Pelton wheel, which is supplied by a flume from Byers' Creek, 600 feet in length, and an 11-inch iron pipe 132 yards in length, with more than 200 feet of fall. An extensive system of tramways has been prepared for conveying the ore from workings Nos. 1, 2, 3, and 4 to the mill.

The

The "surface," which is generally very shallow, has been stripped and washed in several places in the vicinity of the mines, while Jones's Creek, from near shaft B down to the machine, has been entirely streamed for tin. Stream tin has also been obtained in large quantities higher up on the tableland.

From an inspection of the Manager's books, I learned that from the beginning of June, 1889, to the end of May, 1890, 539 tons 3 cwt. 2 qrs. of stone passed through the mill—yielding a total of 48 tons 16 cwt. 1 qr. 16½ lbs. of "black tin."

I received from the manager, Mr. Martin Carkeek, several specimens of white, or nearly white, cassiterite crystals from the alluvial workings in the vicinity of the mines (specimen 56A), and one (No. 59) of "ruby" tin ore in the matrix, from the lode at the 60-feet level.

MOUNT HARTLEY MINES.

I am only able to locate these mines approximately on the map, as a considerable portion of the route traversed was scrub, and I was unable to obtain bearings from two known points. Leaving the Collingwood, a down-hill journey of a little over a mile on a course a little to the north of east brought me to the hotel at Rossville. This is the depôt for a number of stream-tin mines, situated on gullies flowing to the north from the range dividing Wallaby Creek from the Annan River, and on which the Mount Leswell, Collingwood, and other lode mines are situated. About two miles east-south-east of Rossville, through a palm scrub, Wallaby Creek is reached and crossed. The greater part of this distance is in a country rock of chloritic and talcose greywacke. The ascent of Mount Hartley, which is part of the range dividing the coast from the Annan and its tributaries, commences nearly at the right bank of Wallaby Creek. I should judge the mines on Mount Hartley, situated on the western side but near the summit of the range, to be a little over four miles as the crow flies, from the Collingwood, and a little over two miles from the sea. From the Black Prince Claim, a hill-top, which I believe to be situated between the Collingwood and Mount Leswell mines, bore west 7 degrees north. Mount Finlayson, apparently the highest summit in the district, lies a little to the west of south, but the position of this mountain has not yet been charted.

The rock met with on the ascent of Mount Hartley was a granite with very large crystals of orthoclase felspar. In rock of this character is the "No. 1 opening," ten feet deep on the "*Black Prince*" line of lode. The lode runs north 35 degrees west, and is vertical and about 2 feet 6 inches in width, of which width about one-half is "horse." A heap of stone taken from this opening consists of quartz, tourmaline, and arsenical pyrites, with crystals of cassiterite, sometimes of unusually large size (specimen No. 13). The lode appears to die out to the north, and increase in size to the south. The granite in the neighbourhood of the lode for some distance on both sides contains crystals of tourmaline.

About a quarter of a-mile up the spur to the south a second opening (Wright's Lease, No. 99), about 20 feet long by 4 feet wide, has been made in the same line, on a vertical joint running north and south through granite country. The granite in the neighbourhood is talcose and ferruginous. The stone raised shows decomposed arsenical pyrites in a talcose matrix with occasional cassiterite crystals.

In the same lease, rather less than a quarter of a-mile further up-hill (south), a shaft has been sunk to the depth of 42 feet on a lode, the cap of which has been exposed in a nmmber of open cuttings extending for about 54 feet to south 10 degrees east. I did not go down the shaft, as I was informed that it contained foul air. A few tons of stone at the top showed quartz, tourmaline, and arsenical pyrites. The open cuttings average about 10 feet in depth (excluding surface wash), and show the lode to vary from 6 inches at the south end to 3 feet at the north end, and to go down vertically through a country rock of cross-grained decomposing granite. One heap of picked stone, about 8 by 5 by 1½ feet showed quartz, felspar, tourmaline, arsenical pyrites, and a little tin ore. The tin ore is of better quality than it appears at first sight. One sample (No. 15), when crushed and panned off, turned out to be about half tin ore, although its specific gravity and a small quantity of visible cassiterite were the only indications of its richness.

About half-a-mile south of the Black Prince is the "*Caledonia*" Claim. The intervening country rock, as seen in a race cut for the supply of water to alluvial diggings, is chiefly greywacke. Near the north end of the claim an opening has been made about 15 feet long and 15 feet deep, in a fine-grained rock consisting of silica, felspar, and hornblende—apparently a dyke—varying from 18 to 30 inches in width, traversing decomposed slate and greywacke country from north-west to south-east. Down hill to the east about 2 chains, and within the same claim, are some openings extending east 20 degrees south (down hill) for nearly 2 chains, on a dyke of fine-grained matted talc and felspar, varying to felspar and hornblende. The dyke varies up to 3 feet in width. Some stones from the open cutting show a thickness of 6 inches of the talcose rock, fairly rich in tin. I saw fragments from a vein at least half-an-inch thick of nearly pure tin ore (specimen 14). Eight hundred weight of similar ore are said to have been sent away. At the lower end of the open cutting is a shaft 40 feet deep, which, however, is in an unsafe condition. At the surface the dyke is 4 feet in thickness, and, as far as can be seen from the top, it first thins and then thickens. On the hanging-wall side there was a rich leader, which some specimens on the top showed to have been about 2 inches thick, the remainder having been comparatively poor. A tunnel is being driven from the north towards this shaft, and it is estimated that it will cut the dyke at a depth of 200 feet, besides prospecting the ridge for further deposits of ore.

A large quantity of stream tin has been obtained from the gullies on both sides of the Mount Hartley ridge. At present thirty-three men are engaged in streaming.

MOUNT AMOS MINES.

This group of mines is situated on the north-eastern slopes of Mount Amos. It may be mentioned that, from bearings taken from the Marine Surveyor's cairn on the headland north of the mouth of Waterfall Creek, the summit of Mount Amos must be a little further north of its position, as shown in the two-mile map (Sheet 3) of the Cook District. The elevation of the mountain is given as 2,800 feet. The Mount Amos Mine appears, from the sea, to be about half way up the mountain. Mount Browning Mine to the south of the Mount Amos Mine appears to be at about three-fifths of the total altitude of the mountain. The other mines afterwards to be referred to lie between these two mines.

MOUNT BROWNING.

At the foot of the spur near the township and public-house is a peculiar syenite with a matrix mainly quartzose with large blebs of quartz and very large crystals of orthoclase felspar, with the angles sometimes rounded, and small crystals of hornblende. Hornblende is sometimes seen in the interior of the large orthoclase crystals. [A similar syenite occurs in the bare rugged mountain known as "Black Trevethan."] Higher up the spur are slates and greywackes, and at the mine the countryrock is granite of the usual character. The first mining operations met with are about 100 yards above the camp, in granite country, on what is known as the "Black Lode." This appears to be a "pipe" about 14 feet by 6 feet in sectional area, its long axis extending north 10 degrees west, the "pipe" underlying slightly in that direction. Some vertical veins of quartz occur in the tourmaline mass. The "pipe" is being worked by an open cutting, continued to a depth of 15 feet by a shaft. The tin ore cannot easily be seen in the tourmaline, but the specific gravity of the stone is high. Specimens taken at random from the bottom of the shaft at intervals of about 2 feet, some of which were found to contain visible tin ore and some none, yielded as follows on assay:—

No. 62	... ...	10·9 per cent. metallic tin.
No. 63	... ...	traces ,,
No. 64	... ...	4·1 ,, ,,
No. 65	... ...	15·2 ,, ,,
No. 66	... ...	19·8 ,, ,,
No. 67	... ...	18·46 ,, ,,

Crystals of cassiterite are occasionally met with in the soft granite adjoining the "pipe."

A heap of stone, of about 100 tons, showed some rich specimens, but was rather unequal in quality. Specimen 68, from this heap, was evidently rich. It gave on assay 36·3 per cent. of metallic tin.

About 30 feet higher up the hill is the mouth of a tunnel. In a drive above the tunnel a 3 feet lode of tourmaline ore is seen, mixed with porphyry on its foot-wall side. It underlies to the west at 70 degrees. The specific gravity of the ore is high, and sometimes tin ore can be distinctly seen. Specimens taken indiscriminately from the face showed a great deal of fine cassiterite, and in every specimen rich tin ore was visible when the stone was wet.

Beneath this drive the tunnel runs south 12 degrees west for a distance of 65 feet. The lode is first met with twenty-four feet short of the face of the tunnel, nearly beneath the drive above referred to. It underlies to the west, and consists of quartz a good deal mixed with tourmaline, especially on the hanging-wall side. At the face in the tunnel the lode is small, and consists mainly of quartz between walls of granite. I should not be surprised if this deposit also turned out to be a pipe vein. A heap of stone from the tunnel, measuring 15 by 21 by 5 feet, consists of soft tourmaline disguised by kaolin, and evidently rich in tin ore. Samples 69 and 70 appear to be fairly characterstic of the heap, and assayed—

No. 69	... ...	10·9 per cent. of metallic tin; and
No. 70	... ...	0·16 ,, ,,

About 100 feet up the hill from the tunnel a shaft 35 feet deep has been sunk on the "Upper" or "No. 5" lode. At the south end of the bottom of the shaft a vein of kaolin underlying to the west at 75 degrees, intersects granite country. This vein, for a thickness varying up to 3 inches on its hanging-wall side, is charged with or replaced by tourmaline, and for 8 or 10 inches with tourmaline and quartz. A drive has been carried 35 feet to the north of the bottom of the shaft. A few feet north of the shaft there are distinct walls 4 feet apart, and the ground has been stoped out above the level. Six feet north of the shaft (specimens 71 and 72), dug up from the solid floor of the level, showed tourmaline, quartz, talc, and a good deal of tin ore. These specimens gave 15 per cent. of metallic tin on assay. The face of the level shows tin ore distinctly. Six feet above the floor a "head" is seen to carry the lode down to the north at 45 degrees. For the last 12 feet there is no lode in the roof of the level. About 100 tons of stone have been raised from this shaft. The stone consists of tourmaline, talc, and quartz, with tin ore. Some large solid blocks are very rich. Specimen 72A gave 18·5 per cent. of metallic tin. Tin ore was also easily to be seen in the finer debris which had recently been washed by rain.

The cap of a large north and south tourmaline lode, occasionally showing tin ore, runs obliquely down the hill-side below the mouth of the tunnel, through granite country; it is said to be traceable for nearly a mile. A few tons of stone have been taken from the cap. This lode is cut at 70 feet, in a tunnel about 100 feet below the level of the tunnel already referred to; and levels have been carried along the lode for 50 feet to the north and 12 feet to the south. The tunnel and levels were used as a dam for the supply of the camp, so that I could not see the lode. A disused dolly stands near the mouth of the tunnel, and a heap of tailings shows a good deal of tin ore.

A five-stamp battery has just been erected on the side of the gully to the south of the camp, in a position well situated for economical working. Ore dressing machinery is in course of erection.

FIERY STAR.

A shaft 24 feet deep has been sunk on the left bank of the gully south of the machine. The shaft contained 10 feet of water. It is sunk on a large quartz reef underlying to the west at 80 degrees, and containing tourmaline and a little tin ore, with a vein of tourmaline up to 9 inches in thickness in the middle. The lode is traceable for about 1 chain to the south across the bed of the gully, and has also been touched in an opening about 1 chain nearer the machine to the north. Here is a small heap of rich tin ore. Over two tons of "black tin" are said to have been dollied.

What is known as "Lake's Original Opening" is a little below the level of the Fiery Star, and nearer the machine. It is a tunnel 15 feet in length, ending in a short cross-cut to the south on a vein of black tourmaline and quartz underlying to the east. Some very rich specimens are said to have been taken from this opening, which is about 40 feet below the level of the machine.

MURRAY AND McARDLE'S MINES.

These mines are situated on the north-west side of the spur containing the Mount Browning lodes, and at least 400 feet below the level of the latter. A tunnel has been driven south 12 degrees west into the hill side. There was a large bunch of ore in the last 15 feet. It is said to have been the whole size of the tunnel (and it must have been so to produce the quantity of ore excavated). The ore is pinched at the face of the tunnel. I fancy the deposit will prove to take the form of a pipe vein, or there may be more than one pipe in the same line. A heap of high-class ore, at least 60 tons, consisting of tourmaline, a little quartz, and a good percentage of cassiterite lies at the mouth of the tunnel. Specimens 73 and 74 showed a large proportion of tin ore mixed up with fine crystals of tourmaline and a little quartz.

From two other openings on the hill above, nearly in a line with the ore in the tunnel, ore of similar character is being obtained.

GLADSTONE.

This mine occurs on a spur north-west of the Mount Browning spur. A lode 4 to 6 feet in thickness has been stripped for a distance of about 140 feet south-south-east, obliquely up the hill. The lode underlies west-south-west at 65 degrees. It consists of quartz and talc, with a little arsenical pyrites and some tin ore. The latter generally occurs in veins, and on faces associated with arsenical pyrites and tourmaline. Some very rich specimens (No. 75), showing large crystals of cassiterite and a little wolfram, can be picked up. From 1 to 4 feet of stone have been taken off the cap of the lode all along the cutting.

CREIGHTON'S MINE.

This mine lies south of the Gladstone, and at a higher elevation. The lode runs north and south and is nearly vertical, but with a slight dip to the west. It varies from 10 inches to over 2 feet in thickness. Cassiterite can be seen on faces and joints, these joints being generally parallel with the walls. Occasionally tourmaline and occasionally quartz separate out in veins parallel with the walls.

MOUNT AMOS.

An open cutting extends 50 feet from south 10 degrees east to north 10 degrees west, on a lode averaging at least 4 feet in width. The bulk of the lode is of quartz, with veins of tourmaline parallel with the walls. Small tin-ore crystals can be seen on joints and faces. A shaft has been sunk 30 feet from the south end of the cutting to a depth of 10 feet, and shows the lode underlying to the west at 70 degrees. A heap of stone containing from 60 to 100 tons has been raised, consisting of quartz, tourmaline, and a little tin ore. I was informed that about 1½ tons of rich "bagging ore" were sent away from this place. [This was known as "Owen and Davidson's Lease" at the date of my former visit in 1887.]

About 1 chain further up the hill to the north the same lode is exposed in an open working for a distance of about 60 feet from south to north. Portions of the lode near the hanging-wall show tin ore pretty freely in small crystals. In the middle of the lode, over a thickness of about one foot, are angular blocks of granite, with the interspaces filled with tourmaline. Above and below this zone are occasional masses of solid tourmaline. The north end of this cutting lies west 10 degrees south of the mouth of the tunnel afterwards to be referred to.

For three chains further north the lode is easily traceable at the surface by its debris. At the end of the three chains a shaft has been sunk. The shaft looks like 30 feet in depth, and has apparently followed a shoot of ore dipping to the north, but as it had water in the bottom, and the old "Jacob's ladders" did not appear trustworthy, I did not go down. At the mouth of the shaft several "leaders," with a somewhat lower degree of underlie than the lode itself, intersect the granite country and join the lode on its underlie side. A heap of stone from the shaft consists of quartz and tourmaline, a good deal of talc, and some tin ore. Specimen No. 76, from the heap, showed a curious case of broken tourmaline crystals in a matrix of quartz.

A tunnel commencing down the hill at an elevation of perhaps 200 feet lower appears to have been designed to cut the lode near the last-mentioned shaft. The tunnel commences just above the greywacke country and has been carried through granite for a distance of 80 feet west-north-west.

ROBERT L. JACK.

Geological Survey Office, Townsville, 6th December, 1890.

Price 1*s.* 6*d.*]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND

No 1

GEOLOGICAL SKETCH MAP

to accompany

SECOND REPORT ON THE TIN MINES NEAR COOKTOWN.

by

Robert L. Jack

Government Geologist

1890

Scale 2 Miles to 1 inch.

0 2 4 6

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Fritz Ck
Russell Ck
Bauer Inlet
WEARY BAY
N
Mag N
Var. 8°15E

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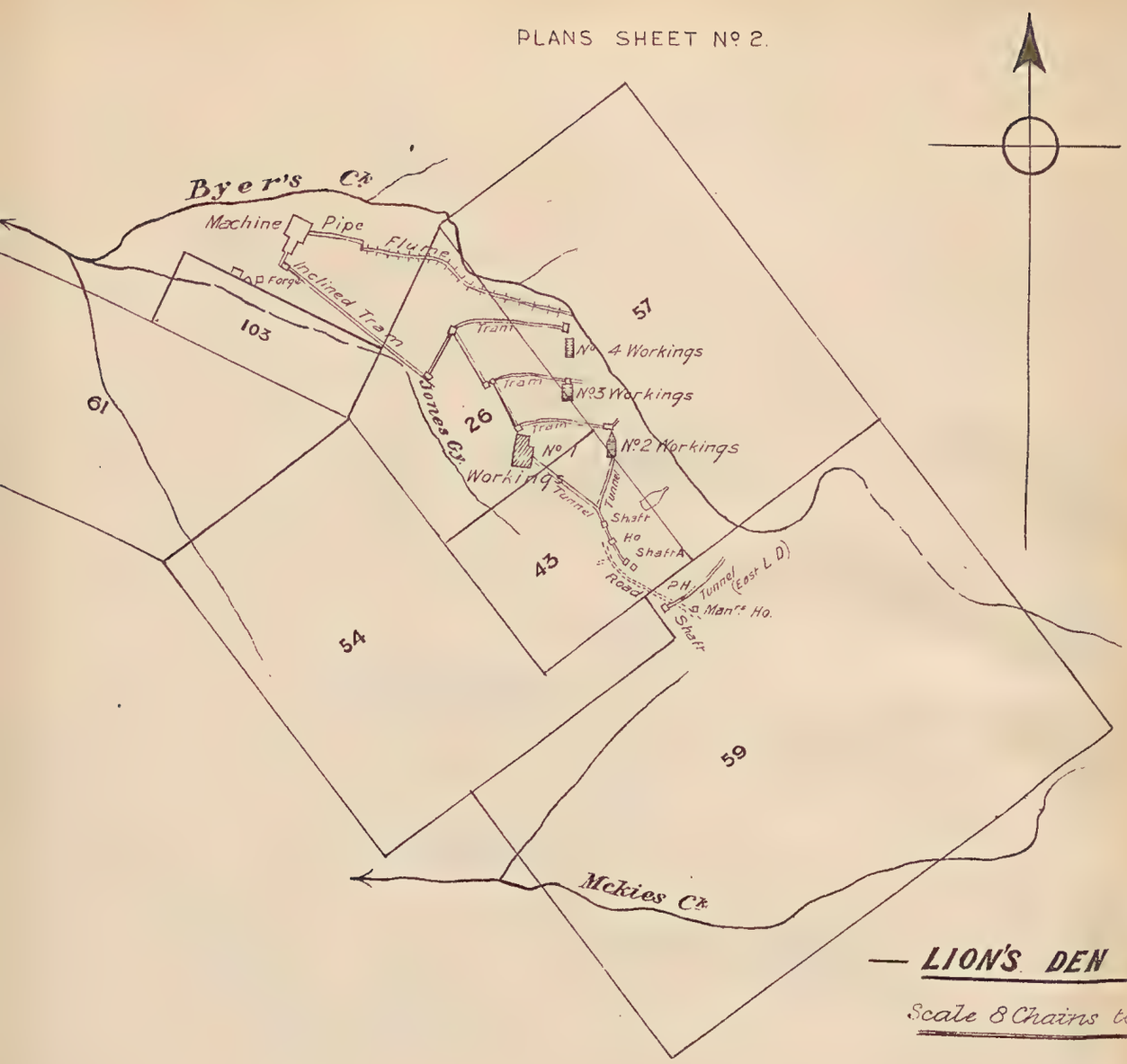
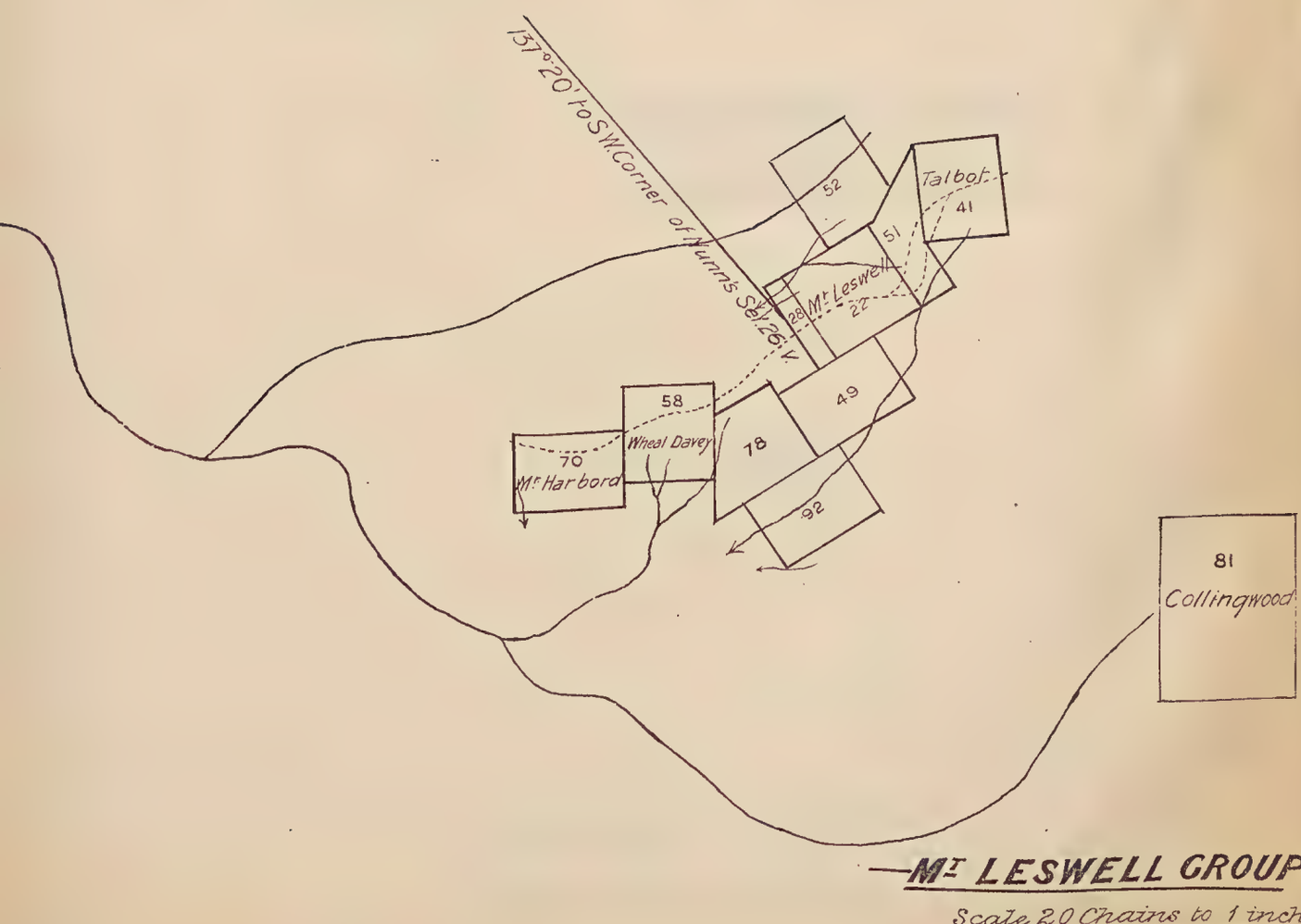
W. KNIGHT, GOVT ENGRAVER.

PLANS SHEET No 2.



— LION'S DEN GROUP —

Scale 8 Chains to 1 inch.



— Mr LESWELL GROUP —

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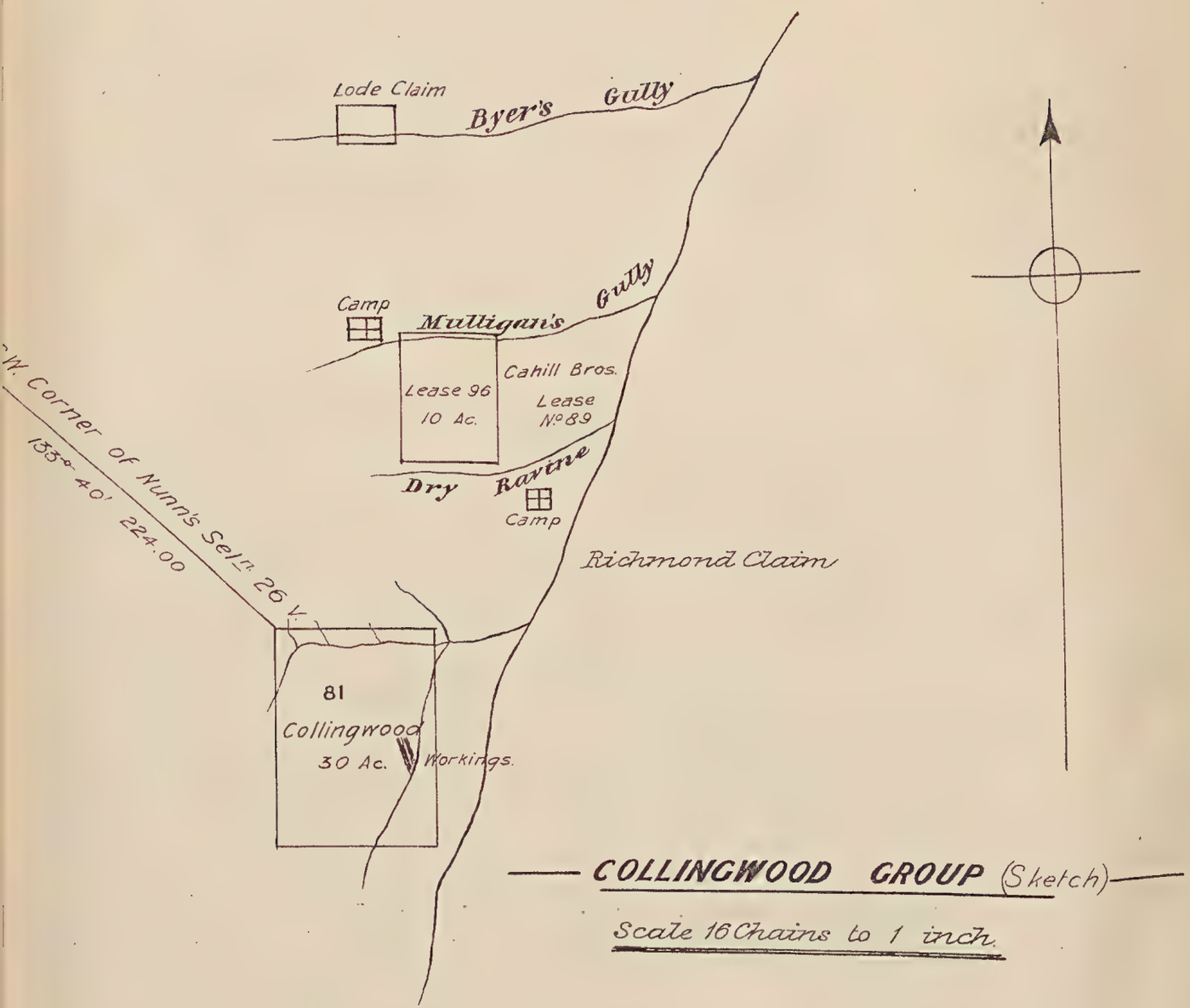

COLLINGWOOD GROUP (Sketch)

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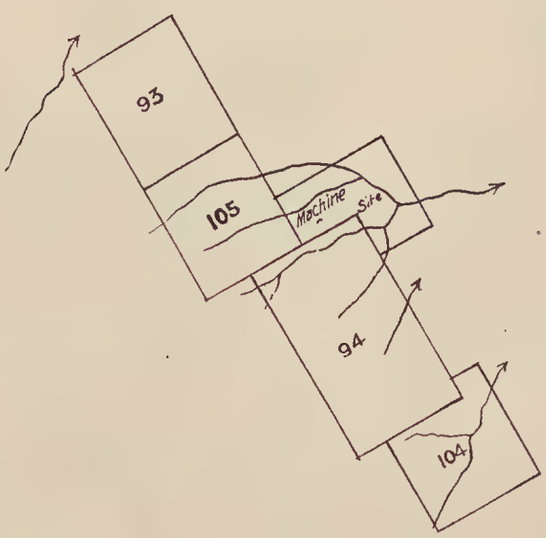


Mt AMOS LEASES

Scale 16 Chains to 1 inch.

VITH
W. H. Rands' Compliments.
GICAL SURVEY OFFICE,
BOROUGH, QUEENSLAND.

1891.

QUEENSLAND.

PARADISE GOLD FIELD.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON THE)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

The Paradise Goldfield is situated on the south side of the Burnett River, about eight miles north-west of Degilbo Station, and about two miles below the mouth of Yarrabil Creek—the creek on which Gebangle is situated.

Gold was discovered in reefs here about the middle of the year 1889, by Messrs. Allen and party. In my report on Gebangle, &c., published early in the year 1890,* I mentioned two reefs as being prospected in this district. Only during the last six or eight months, however, have any number of people been attracted to this field, and during that time fresh reefs have been discovered and prospecting has been going on apace.

At the present time the population of the field is estimated at about 400. There are between 90 and 100 miners, about half of whom are on wages, and the remainder are working reefs on their own account.

The reefs extend back for a distance of two miles from the Burnett River, and are situated on the steep ridges which lie between Scrubby or Paradise Creek, and Finney's Creek. The site of the township is on the alluvial flat which fringes the River.

The field at present is not a large one; it covers an area of from one and a-half to two miles in a north and south direction, by, say, an average of half-a-mile in an east and west direction. Very similar rock, however, extends over a much larger area, so that there is every probability of an extension of the area over which gold-bearing reefs will be found.

The country rock is for the most part a hard dark-coloured siliceous slate, with altered sandstone in places. It is only here and there that the dip of the slates is sufficiently defined to be determined.

In the neighbourhood of the Paradise P.C. and Leishman's William Tell, and crossing the ridge along which the road to Mount Shamrock runs, there is a porphyry with a granitic structure, and consisting of about equal parts of quartz and felspar. The area occupied by this rock is enclosed in a dotted line and marked *P* on the plan attached to this Report. The Paradise P.C. shaft has passed through this rock down to its present depth, 130 feet.

All the way down Yarrabil Creek, from Gebangle to near its junction with the Burnett, slates and sandstones dip steeply to the north-west. On the north-eastern side of Scrubby or Paradise Creek, near its junction with the river, there are ridges containing thick beds of a white crystallised limestone running in an east-north-easterly direction. I was unable to detect any organic remains in this limestone. Nearer the creek there was another bed of similar limestone running in a more northerly direction.

The reefs run in various directions, but the majority of them have a more or less easterly and westerly bearing. Most of them are approaching the perpendicular; the Lady Margaret Reef, which underlies very flatly to the west, is a notable exception. Several of the reefs are small, as will be seen from the description below; in many cases they appear to be increasing in size at a depth, and the stone is quite as rich as in the narrower portions of the reef. The latest development in the Paradise P.C.—the deepest shaft on the field, where over 5 feet of quartz in width has been cut through at a depth of 130 feet—speaks well for the prospect of the reefs at a depth.

The quartz has generally a faint bluish tint, caused by finely-divided pyrites occurring throughout it. It contains also larger specks of pyrites and minute particles of galena and zinc-blende, though these latter minerals are by no means common. The gold exists in a very finely-divided condition, and it is not often that it is visible in the quartz.

So far as prospecting up to the present has gone the gold appears to be disseminated very regularly through the reefs, and not to run in "shoots," as is usually the case.

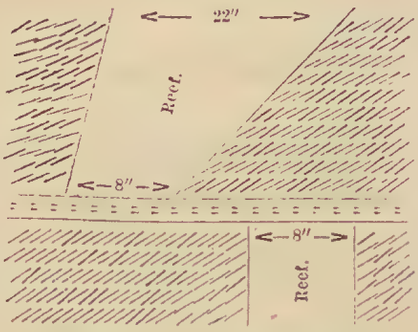
The crushings amount in the aggregate to 552 tons, which have yielded 1,068 ounces of gold, or a little under two ounces of gold to the ton—an exceptionally good return when it is remembered that these crushings are from eight different claims, and from ten or eleven separate reefs.

On account of the fineness of the gold it will be necessary to use the best gold-saving appliances to prevent great loss occurring. The appliances at present in use on the field consist of a Huntington Mill, with a self-feeder, the quartz being broken up in a stone-breaker. From this mill the material passes

* "Report on Mount Biggenden Mine, Gebangle, and the Mount Shamrock Mine," by William H. Rands, Assistant Government Geologist. Brisbane—By Authority: 1890.

No. 1 *West Nil Desperandum* is another protection area of 150 yards by 150 yards. A shaft was being started on what is probably the same reef as in the P.C. The reef consists of from 18 inches to 2 feet of bluish quartz with pyrites, in which gold is at times visible.

No. 1 *East Nil Desperandum.*—The work done here is certainly on the same reef as the P.C. The reef, which is large and well defined, is thrown a few feet to the south by a fault. About 50 yards east of the shaft the same reef is being worked in a tunnel, and is displaced by a horizontal "fault or break."



Section showing "Break."

The Philadelphia Claim.—Area of claim 550 feet by 400 feet. This claim is situated about 20 chains south-south-east of the Lady Jane. The reef is nearly perpendicular, and bears north 15 degrees west. Two shafts have been sunk on the reef about 38 feet apart. The southern shaft is 60 feet in depth. The reef has been stoped between the two shafts from 50 feet level up to near the surface. The average width of the reef is from 12 to 14 inches, but it bulges out to a much greater width in places. This shaft is being sunk to meet the drive from the northern shaft at the 75 feet level. The reef is increasing in width near the bottom, and gold is showing in it. In the bottom it consists of a white quartz containing fine pyrites.

The Northern Shaft is 98 feet in depth. The reef in the bottom of this shaft is very small. In the 75-feet level it averages about 8 inches in width, and is on the hanging-wall near the shaft, and then changes over to the foot-wall; it then breaks back in steps towards the hanging-wall again. The country is a dark siliceous slate at the surface. At the bottom of the shaft it is black clay slate. The crushings from this reef are—

20½	tons	yielded	47	ounces	of gold
30½	„	„	79	„	„
31	„	„	42	„	„
19	„	„	28	„	„

or 101 tons yielded 196 ounces of gold, equal to 1 oz. 19 dwts. of gold per ton. A crushing was taken from this shaft by a former company, which went only 11 dwts. of gold per ton; but I understand that they were working only in a mullocky formation, leaving the reef on the foot-wall.

No. 261 *Claim* is a protection area of 300 yards by 300 yards. It is situated 13 chains south-east of Bushnell's. The reef bears west 20 degrees north, and underlies slightly to north 20 degrees east. The reef pinches and then bulges out a good deal; it averages about 6 or 7 inches. In the face of the western drive the reef in the middle is 7 inches wide, while at the floor and roof it is only 2 inches. The quartz contains layers of pyrites through it. The country-rock is a hard siliceous slate. In the eastern drive, 40 feet from the shaft, the reef is about 10 inches in width; it crushed here nearly 3 ounces of gold to the ton. Eight feet from the face of the drive, a north and south fault dipping west throws the reef about one foot to the south. At the end of the drive the reef is pinched. The reef has been stoped up for a height of 20 feet. The crushings are—

29	tons	yielded	50	ozs.	10	dwts. of gold
18	„	„	50	„	0	„ „

The Trent Lily Claim.—A protection area 150 yards by 150 yards. The shaft on this claim is 20 yards west, 20 degrees north of No. 261. It is down 20 feet, and is being sunk to cut the same reef.

The Lady Margaret.—The area of this claim is 500 feet by 400 feet. The shaft is 75 yards south-south-west of No. 261. The reef runs north-west and south-east, and underlies flatly south-west at 60 degrees. The shaft is in on the underlie about 70 feet. The reef is small but rich; it averages about 4 inches. Several leaders are coming in at the bottom of the shaft. Another reef is being worked above this, consisting of a rubbly quartz. It bears north-north-west, and underlies west-south-west at 45 degrees. It is from 8 to 9 inches in width and shows gold freely.

The crushings from this claim are—

19¾	tons	yielded	69	ounces	of gold
23	„	„	78	„	„

or 42¾ tons yielded 147 ozs. of gold, equal to 3 ozs. 8 dwts. 7 grs. of gold per ton.

Penny's Claim.—A protection area 150 yards by 150 yards. In this claim there are as many as eight reefs showing at the surface. The reefs have a more or less east and west "strike." Only surface prospecting work was being done, and no permanent shaft had been started. One of the reefs is a good size—from 2 feet 6 inches to 3 feet at the surface.

The Caledonia Lode.—Is situated about 13 chains a little south of east of the Philadelphia. The lode runs north 25 degrees east, and underlies west 25 degrees south. The depth of the shaft is 20 feet.

At

At the surface there was a "blow" of rich copper ore, which continued downward 2 or 3 feet, and was only a few feet in length. Below this ore was a yellow gossan, passing into a red gossan lower down. The red gossan was followed down to a depth of 13 feet, and then was lost, with the exception of small veins which disappear in the western side of the shaft. At the bottom of the shaft there is a reddish slate or shale. A small drive was put into the east to try and cut the lode. The lode will probably be picked up to the west of the shaft, as it is underlying in that direction.

The best ore contained 31·2 per cent. of copper, and £12 10s. 0d. per ton was offered for ore similar to sample.

The slate here dips west at 40 degrees.

WILLIAM H. RANDS,
Assistant Government Geologist.

APPENDIX.

Crushings for Reefs on the Paradise Goldfield.

		Yield. Ozs.	dwts.	Total. Ozs.	dwts.
Paradise P.C.	148 tons (surface to 76 feet in depth) ...	151	0		
	21½ „ (80 ft. level)...	57	0		
	28 „ (No. 2 shaft)	26	0		
	12 „ (new reef)	13	0		
				247	0
Protection Area No. 261	29 tons (from two shafts) ...	50	10		
	18 „ (present shaft 40 feet) ...	50	0		
	12 „	30	0		
				130	10
Protection Area No. 259	38 tons (surface to 40 feet) ...	30	10		
	17¾ „	23	0		
	12 „	12	0		
				65	10
Philadelphia	20½ tons	47	0		
	30½ „	79	0		
	31 „	42	0		
	19 „	28	0		
				196	0
Lady Margaret	19¾ tons	69	0		
	23 „	78	0		
				147	0
Lady Jane	3½ tons	22	0		
				22	0
Berrie-Pattison	48 tons	194	0		
	13½ „ (crushed at Mount Shamrock) ...	50	3		
				244	3
Gympie Company (Neill's)	2¼ tons	8	10		
	5 „	6	10		
				15	0
	552 tons			1,067	3

Price 1s.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

With the compliments of
Robert L. Jack,
Government Geologist.
GEOLOGICAL SURVEY OFFICE,
TOWNSVILLE, QUEENSLAND.

1891.

QUEENSLAND.

THE GEOLOGY OF THE COOKTOWN DISTRICT.

(REPORT BY A. GIBB MAITLAND, ASSISTANT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

This Report is intended to describe the geology of the district in the neighbourhood of Cooktown, with especial reference to the coal deposits in the desert sandstone, and is accompanied by a geological map (based on surveys by Mr. R. L. Jack, with additions by myself) upon a scale of four miles to the inch, and two sheets of horizontal sections intended to show the structure of the country.

THE GEOLOGY OF THE DISTRICT.

Pre-Permo Carboniferous Rocks (s).—The broad geological features of the district have been ascertained by Mr. R. L. Jack in the years 1879 and 1887, and since then few fresh geological data have been brought to light.

For a correct understanding of the relations of the coal deposits a general examination of the older rocks had to be undertaken.

The result of such examination showed that these older rocks consist for the most part of greywackes, slates, and quartzites, which have undergone a certain amount of folding and contortion, and which have subsequently been penetrated by granitic rocks.

The range, a spur from Mount Cook, is crossed by the road to Hamilton, a township on Oaky Creek, and is found to be made up of greywackes and shales, which have a dominant strike to the north-west, and a slight dip to the north-east.

On the south bank of the Endeavour at Marton, greenish talcose (?) slates stand out very prominently from the ground, and have a strike to north 10 degrees east.

Along the road to Hamilton from Cooktown, slates, greywackes, and quartzites are exposed at intervals in the creeks and on the hill sides.

Where the road crosses Oaky Creek at the Hamilton township, the strike of strata has veered round to north 20 degrees west.

Dickson's Range or Cunningham's Tableland, which occupies a portion of the country between Oaky Creek and the Endeavour River, capped with horizontal sandstones, is made up of vertical quartzites and shales, which have a dominant trend to the north-east.

The heads of Oaky Creek drain country composed of contorted shales and greywackes, with a north-westerly strike.

On the road from Hamilton to King's Plains, between the Lookout and the Barron Ranges, a series of vertical limestones, interstratified with beds of slates, are to be seen. They have a general trend of west-north-west. One bed is said to be coated along joints with fibrous serpentine.*

Similar sedimentary strata crop up at intervals in the country to the north of the Endeavour River; they everywhere bear very much the same general characteristics. The strike, however, varies very much locally.

In the bed of Carrol Creek, a tributary of the right-hand branch of the Endeavour, west of selection 140, the strike of the slates which underlie the basalt is east and west; in Piebald Creek it has changed to the north-west, while at India Head it is north-easterly.

Interstratified with the rocks above described are what appear to be volcanic ashes and breccias, and it is not improbable that certain rocks, "porphyry" and "silicated felstone," may on future examination turn out to be lava flows.

A very good example of these ashes is to be seen on a ridge about a mile distant to the north of the township of Evandale, and on the eastern side of the Cooktown road; the beds stand out very prominently, and can be traced by the eye for a considerable distance. A section of somewhat similar beds is to be seen in the Cliff sections at India Head on the north shore.

Near the head of Deep Creek, a tributary of the Normanby River, a "white silicified felstone" is mentioned as occurring among hard greywackes and slates, the strike of which is to the north.

Almost due east of Ruby Hill Station, on the eastern bank of the Normanby, and cropping out beneath the horizontal sandstones which cap the neighbouring heights, are a series of coarse acidic ashes (?).

In addition to the slates, greywackes, and quartzites above described, mica schists with a general northerly strike are observable in some portions of the district.

These can be well seen in the neighbourhood of Ruby Hill Station.

They are penetrated by a micaceous granite, of which several bare seams expose good sections.

Between

* R. L. Jack—M.S. Notes.

Between the granite and the schists no very distinct line of demarcation can be drawn, nor, with what little knowledge is at present possessed, is it possible to distinguish between the mica schists and the comparatively unaltered slates, &c. Doubtless the two are but portions of one and the same series of beds.

Sections exposed at the foot of Grassy Hill, Cooktown, help to support this view. On the northern face of the hill the granite is seen to penetrate the slates in several places, but these have not undergone that amount of alteration by which those of the Ruby Hill District are characterised.

The question of the geological age of these beds remains yet an unsolved problem. That they are pre-permo carboniferous is all that can be said of them, in the light of such evidence as is at present to hand.

COAL MEASURES. (*Permo Carboniferous*—(H).

I had no opportunity of visiting the small area of coal measures which are exposed in Oaky Creek and its tributaries. The following description is compiled for purpose of comparison from the reports already published.*

Section III., across the Oaky Creek Coalfield upon a scale of 6 inches to the mile, is drawn from data collected by Mr. R. L. Jack during his survey of that field.

The Oaky Creek Coal Measures consist of sandstones, shales, fireclay, and thin coals.

Some of the beds have yielded plant remains, by which the coal measures are classed as being presumably the equivalent of the upper freshwater series of the Bowen River Coalfield.

In Oaky Creek these strata, which have undergone a deal of disturbance, rest unconformably on the older rocks above described.

The horizontal sandstones of the "Brothers," a table-mountain on the divide between Oaky Creek and the Normanby River, are seen to rest directly upon the upturned edges of the coal measures.

Wherever exposed to view the strata dip at high angles to the west.

"As a great thickness of the coal-bearing strata dips under the sandstone of the 'Brothers' on "the east side of that range, and does not re-appear on the west side (where the sandstone rests immedi- "ately on slates), the coal-bearing strata must be bounded on the west by a fault which passes beneath "and does not disturb the horizontal sandstones."†

This is shown in Section III.

Several seams of coal have been discovered and described, but in no case was any seam of greater thickness than 8 inches met with.

DESERT SANDSTONE ROCKS—(D).

It is the desert sandstone rocks with their associated coals that it is the main purpose of the Report to describe.

The beds of the Endeavour River, the Normanby River, and the Welcome Valley, have been examined and described by Mr. R. L. Jack in the years 1879 and 1887. In the description of the latter‡ no definite conclusion as to the age of the Welcome Valley Beds was arrived at. Subsequent examination shows them to be of desert sandstone age.

Wherever examined they present very much the same lithological characters.

For the most part they consist of coarse sandstones, grits, and conglomerates. Many of the sandstones in the higher portions of the series contain large quantities of hæmatite in the form of irregular nodules.

Fine-grained flaggy sandstones (with streaks of coal), shales (some of a buff colour), and thin coals also occur, but they form a relatively small portion of the series.

A fine ashy sandstone, similar to the sandstone described as occurring at the base of the desert sandstone in the Cape York Peninsula, near the Lukin River, at Pera Head, north of the Archer River and Pisonia Island, one of the Wellesley Group, off Point Parker, is to be seen at one portion of Battle Camp Range, resting upon the sandstones and grits to be described below.

Nowhere do these rocks appear to have undergone much disturbance since they were formed.

At Guppy's Tableland, between Cape Bedford and India Head (section II., sheet 1), the base of the desert sandstone, which rests with a violent unconformability upon the upturned edges of the quartzite, greywackes, and slates, is by aneroid 560 feet above the high-water mark on the beach.

The lowermost bed consists of a coarse quartzose conglomerate of 70 feet in thickness, succeeded by about 50 feet of fine-grained flaggy sandstones, with shales and thin coals, and in turn overlain by about 300 feet of coarse massive grits.

The following is a section in descending order :—

	ft.	in.
Massive grits with coal streaks	300	0
Carbonaceous shale with thin sandstone partings	7	0
Coal (Guppy's seam)	0	6
Fine-grained sandstone with thin shales	6	0
Black sandy shale with coal streaks	3	10
Sandstone	2	0
Shale	0	6-8
Sandstone	0	10
Dark shale with coal streaks	0	6
Fine-grained sandstone (with an irregular base) and thin shales ...	6-8	0
Fine-grained flaggy sandstone with thin lenticular beds of sandy shale	10-12	
Quartzose conglomerate	70	0

Guppy's coal seam has been opened up, but no fresh light is thrown upon the section. There is no underclay or "seat earth" beneath the coal.

A sample

* "Preliminary Reports of the Geological Survey of Northern Queensland"; "No. 3, Progress of the Search for Coal in the Cook District"; "No. 4, Second Report on the Progress of the Search for Coal in the Cook District"—Brisbane: By Authority, 1879.—"Report on Explorations in Cape York Peninsula, 1879-1880."—R. L. Jack—Brisbane: By Authority, 1880.

† "Report on Explorations in Cape York Peninsula, 1879-1880." R. L. Jack—Brisbane: By Authority, 1880.

‡ "Geological Observations in the North of Queensland," p. 13. R. L. Jack—Brisbane: By Authority.

A sample of this seam, collected by myself, yielded on analysis—

Moisture ...	2·32
Volatile hydrocarbons	15·20
Fixed carbon	72·83
Ash	9·65
	100·00

The specific gravity is 1·66. The ash is of a yellow colour.

None of the beds in the section at Guppy's Tableland have yielded any fossils, with the exception of a few plant remains, rootlets and fragments of leaves, from some of the carbonaceous shales.

Fragments of coal are not uncommon in the upper grit.

The section exposed at India Head is similar to that at Guppy's Tableland, with the exception that the total thickness of strata is not so great, there being only about 300 feet. The base lies at an altitude of about 800 feet above high-water mark. The lower and upper grits are continuous from Guppy's Tableland, but they are separated by a smaller thickness of flaggy sandstones and very sandy shales.

A seam of coal is said to occur among these beds, doubtless a continuation of that seen in Guppy's Tableland.*

From this point westwards, the next outlier of sandstone is at Mount Fantastic; this consists of about 100 feet of sandstone, with neither shales nor coal.

The tableland between Mount Fantastic and Connor's Knob is of sandstone, as is also Connor's Knob.

In examining the cliffs to the north of the Endeavour, near its head, I saw nothing of any of the shales, the whole section appearing to be coarse massive sandstones.

The hills in the neighbourhood of Brannighan's Bluff, in Isabella Creek, are reported to contain a thin seam of coal.

Crossing the divide into the waters of the Normanby (section I., sheet 1), the desert sandstone beds are found to be represented by sandstones and grits without any of the intervening shales. The base near the railway is at an altitude of 400 feet above the sea-level.

In the distance intervening between India Head and the Normanby the coal-bearing shales have disappeared.

The shales make their appearance, however, in a small synclinal trough seen in the railway cuttings near the 37-mile peg, at an altitude of about 430 feet above sea-level, or 200 feet below the horizon of those at India Head.

At the eastern end of the section, at the 36-mile peg, the desert sandstone beds (section I., sheet 2) rest presumably upon granite, which is seen in *situ* 200 yards distant to the southwards.

A ridge of massive quartzite is seen to rise from beneath the sandstones at the 37-mile peg (section IV., sheet 2).

A cutting to the east of Battlecamp Creek exposes a conglomerate with pebbles of greywacke and quartzite resting unconformably upon the massive quartzite mentioned above. The conglomerate is covered with 4 feet 6 inches of black shale, and that again by sandstone, the whole series dipping at angles varying from 5 to 7 degrees to the east.

Buff-coloured sandstones are seen to lie beneath these at the 37¼-mile peg.

A cutting at the 37¾-mile peg shows nothing but very false-bedded sandstones of a reddish-white hue, with a few "false dykes"—*i.e.*, fissures which have subsequently filled in with sandy matter.

Beneath this false-bedded sandstone lies 3 feet of shale which dips at 5 degrees to the west. This rests on a continuation of the sandstone seen at the 37¼-mile.

Dipping at 3 to 5 degrees to the north is a bed of black shale, at the 38-mile.

At the 38½-mile this is underlain by greyish sandstone with ironstone nodules. The hills on either side of the line are made up of nearly horizontally bedded rocks.

Coarse grit, conglomerate, and a thin bed of shale are seen in the cutting at the 38¾-miles. Some of the coarser grits and conglomerates contain kernels of shale.

On the south side of the line, near the 39-mile peg, granite rises from beneath the grits.

About a mile and a-half south of the 40-mile peg a bed of carbonaceous shale with coal streaks, crowded with reed-like plants, too fragmentary for determination, is laid bare in one of the branches of Welcome Creek.

The shale has a dip of 5 degrees to the west-south-west; it rests upon a bed of fine-grained sandstone of a greenish hue.

A shaft has been sunk upon the shales, but apparently abandoned a long time previously. A traverse from this point to the foot of the highest point in the district—a conspicuous hill two miles to the south—shows nothing else but well-nigh horizontal sandstones. The sandstone capping the summit of the hill is very fine-grained; its mural face contains many small caves which have apparently served as hidingplaces for the natives.

As viewed from the summit, the whole of the Welcome Valley appeared to be made up of similar bedded rocks.

Fine-grained yellowish sandstones with a low dip to the west is laid bare at the 40¾-mile peg.

The Battle Camp Range lies to the north of the line at this point (section I., sheet 1).

It is composed of alternations of grits and sandstones, disposed with a gentle dip to the south-east: one bed was found to contain annelid tracks.

The summit, 870 feet above sea-level, is made up of a fine ashy(?) sandstone, which rests apparently conformably upon the other rocks.

This ashy (?) sandstone only attains a thickness of about 40 feet, and is not continuous over a large area. In its lithological characters it agrees with those occurring further north in the Cape York Peninsula.

I searched

* I made two journeys to see the coal at India Head, but, to my regret, in neither were my guides successful in finding the spot.

I searched in vain for fossils, annelid tracks being all I could discover. (It was from the northern face of this range that Mr. Norman Taylor, the geologist attached to Hann's Expedition in the year 1872, discovered *Stienites* and *Ostrea*.)

From the summit, as far as the eye could reach, nothing but horizontally bedded rocks could be seen.

A little distance east of the 41½-mile peg a quarry has been opened for ballast on a horizontal sandstone of the usual type.

A similar sandstone is seen in a cutting between the 43½ and the 43¾-mile pegs.

Another ballast quarry has been opened to the south of the line—the 44½-mile, and distant about 150 yards; the sandstone is fine in grain and of a white colour.

Reddish-yellow fine-grained sandstone dips to the east at angles varying from 5 to 10 degrees in the vicinity of the 44¾-mile peg.

A conspicuous escarpment of coarse gritty sandstone trends east and west, distant about 200 yards to the south of the 47¼-mile peg; a similar cliff—probably a continuation—occurs about half-a-mile to the south-east of the 49-mile peg.

In the vicinity of the 55½-mile, within 200 yards of the line on the south, a series of fossils were collected from a bed of fairly coarse grit which occupies the greater portion of the neighbourhood. The fossils, which resemble very closely those occurring in the desert sandstone of Croydon, consist of *Maccoyella* (?), internal casts of *Rhynchonella*, and others which I have not yet been able to determine.

From this point to the Railway terminus at the Laura River nothing but sandstones of the usual type occupy the country on both sides of the line.

Five miles up the Laura from the railway crossing the following section is seen in descending order, in a cliff in the river:—

	Ft.	in.
Grits with Pebbles	8-10	
Shale	1	0
Coal	0	2
Shale	0	3
Grey Sandstone	0	0
Sandy Shale	0	10
Fine-grained Sandstone	1	8
Bluish Sandy Shale	1	9
Coal	0	5
Sand Shale	1	6
Sandstone	0	0

The whole of the beds lie horizontally.

In this section there is an absence of underclay or seat-earth beneath the coal.

An intrusive section is to be seen in Puckley or Sandy Creek (section V., sheet 2).

The altitude of Mount Ruby Station is by aneroid 420 feet above sea-level. A traverse from this point to the divide between Leichhardt and Puckley Creeks showed coarse grits, lying horizontally upon granite at 1,000 feet above sea-level.

The summit of the divide is 1,250 feet, thus giving a thickness of 250 feet of sedimentary rocks at the head of Leichhardt Creek.

When, however, the waters of Puckley Creek are followed down, it is found that the thickness of the sedimentary beds has increased to 520 feet.

From the summit to 850 feet the whole of the rocks consist of coarse grits and conglomerates. At 380 feet below the summit, or 870 feet above sea-level, two seams of coal are seen to be interstratified with the grits.

A section in the bank of the creek shows the lower seam of coal to be 9 inches in thickness, 3 inches of the base of which is crowded with quartz granules, to such an extent as to make it an open question whether the rock should be called coal, or merely a carbonaceous grit. Above this 9-inch seam lies a thin bed of grit 2 inches thick, and this is covered by another coal seam of 4 inches.

A sample of the coal from the upper portion of the 9-inch seam was taken and submitted to analysis with the following result:—

Moisture	0·33
Volatile Hydrocarbons	30·13
Fixed Carbon	39·34
Ash	30·20
	100·00

The specific gravity is 1·51. The ash is grey in colour.

A little distance west-north-west from the outcrop in the creek a shaft had been sunk through sandstone, to a depth unknown to my informant, with the object of meeting the coal. The shaft had been abandoned sometime, and I was unable to descend.

In the section described above there is an absence of underclay or seat earth. The coal rests directly upon coarse grit.

It would appear as though the coal had been formed in such a position as would allow of ill access of sandy matter.

The high percentage of ash as well as the gritty character of the base gives credence to this view.

Following the windings of the creek for a mile or two down its course sections show nothing but fine-grained argillaceous and micaceous sandstones, with nodules of ironstone and small pellets of coal. The beds roll about a good deal, but their dip never measured more than from 5-7 degrees northwards.

They rest upon a coarse sandstone described* as occurring at the spot where Puckley Creek falls over a wall of granite 50 feet high.

From

* "Geological Observations in the North of Queensland." R. L. Jack—Brisbane: By Authority.

From this point to the railway the country is occupied by granite of the usual type.

About a mile below the railway bridge a bed of coarse sandstone dips at a low angle down the creek; it is seen to rest upon granite.

It will be seen from the altitudes given that the Welcome Valley beds occupy a position below those at the head of Puckley Creek.

For the purpose of comparison the analyses made of the desert sandstone coals have been thrown into a tabular form.

The description of the localities from which the coals analysed by Mr. R. L. Jack need not be repeated—it will be found by referring to the report on "Geological Observations in the North of Queensland" already quoted.

Analyses of the Cretaceous Coals of the Cooktown District.

——	1	2	3	4
Moisture	8·25	7·16	0·33	2·32
Volatile Hydrocarbons	30·42	20·96	30·13	15·20
Fixed Carbon	42·31	35·35	39·34	72·83
Ash	19·02	36·53	30·20	9·65
Specific Gravity	1·83	1·55	1·51	1·66

1. Locality—About three miles south of the 4-mile peg, Cooktown Railway; analysed by R. L. Jack.
2. Locality—About four miles up the valley of Puckley Creek, above the railway crossing; analysed by R. L. Jack.
3. Locality—Near the head of Puckley Creek; analysed by A. Gibb Maitland.
4. Locality—Guppy's Tableland, North Shore; analysed by A. Gibb Maitland.

After entering the valley of Welcome Creek, it will be seen that the thickness of the desert sandstone beds increases somewhat rapidly to the westwards. At the 36-mile peg their base is from the railway survey 348 feet above sea-level. Between this point and the Laura terminus, which is 269 feet in height, the country is occupied by one continuous series of sedimentary rocks, disposed in a series of scarcely perceptible undulations, but with a gradual dip westwards.

The total thickness of strata at the head of Puckley Creek is 520 feet; between the base of these and the top of the grits seen below the Puckley Creek Bridge, 350 feet above sea-level, there is room for not less than 500 feet of rock. The sandstones of the Battle Camp Range, which rise to a height 500 feet above the beds at the 36-mile peg, are probably the representatives of the beds which occupied this gap.

The Welcome Valley beds—by which term is meant the whole of the series of rocks between the 36-mile and the Laura terminus—thus occupy a position below those described as occurring at the head of Puckley Creek, and also below those of the Battle Camp Range.

It would be rash to venture upon an estimate of the thickness of the beds of the Welcome Valley, for there has been no evidence brought forward to throw any light upon this point.

The minimum thickness of desert sandstone lying above the 36-mile-peg, where the Welcome Valley beds are first seen, is not less than 1,000 feet—more than double that occurring in the Endeavour waters.

Another point which the examination of this district has brought out is the existence of a ridge running approximately parallel with the Normanby River north and south. To the west of this ridge was a valley or hollow in which the Welcome Valley beds were deposited. Where the western boundary of this hollow existed it would be premature, with the meagre evidence before us, to state. To the southwards, however, near the head of the Laura River in the Palmer River Waters, the Railway Survey gives the altitude of the base of the desert sandstone as being 1,100 feet above sea-level.

A circumstance worthy of note is the entire absence of an "underclay" or "seat earth" from any of the cretaceous coals of this district which have yet been described.

The coals either rest directly on grits or very sandy shale, and one of the coals—that from Puckley Creek—has its base crowded with quartz grains. Some of the shales contain very thin laminæ of coal, which are not continuous for any great distance. These peculiarities are due to the conditions under which the coals were formed.

The only explanation is that the coals were formed in such a way as to allow of frequent and intermittent access of sand and muddy matter. The coals may really be regarded as subaqueous.

It would be foreign to the purpose of this Report to discuss the volcanic activity which followed the denudation of the desert sandstone.

This has already been described in the reports upon the Cape York Peninsula above quoted.

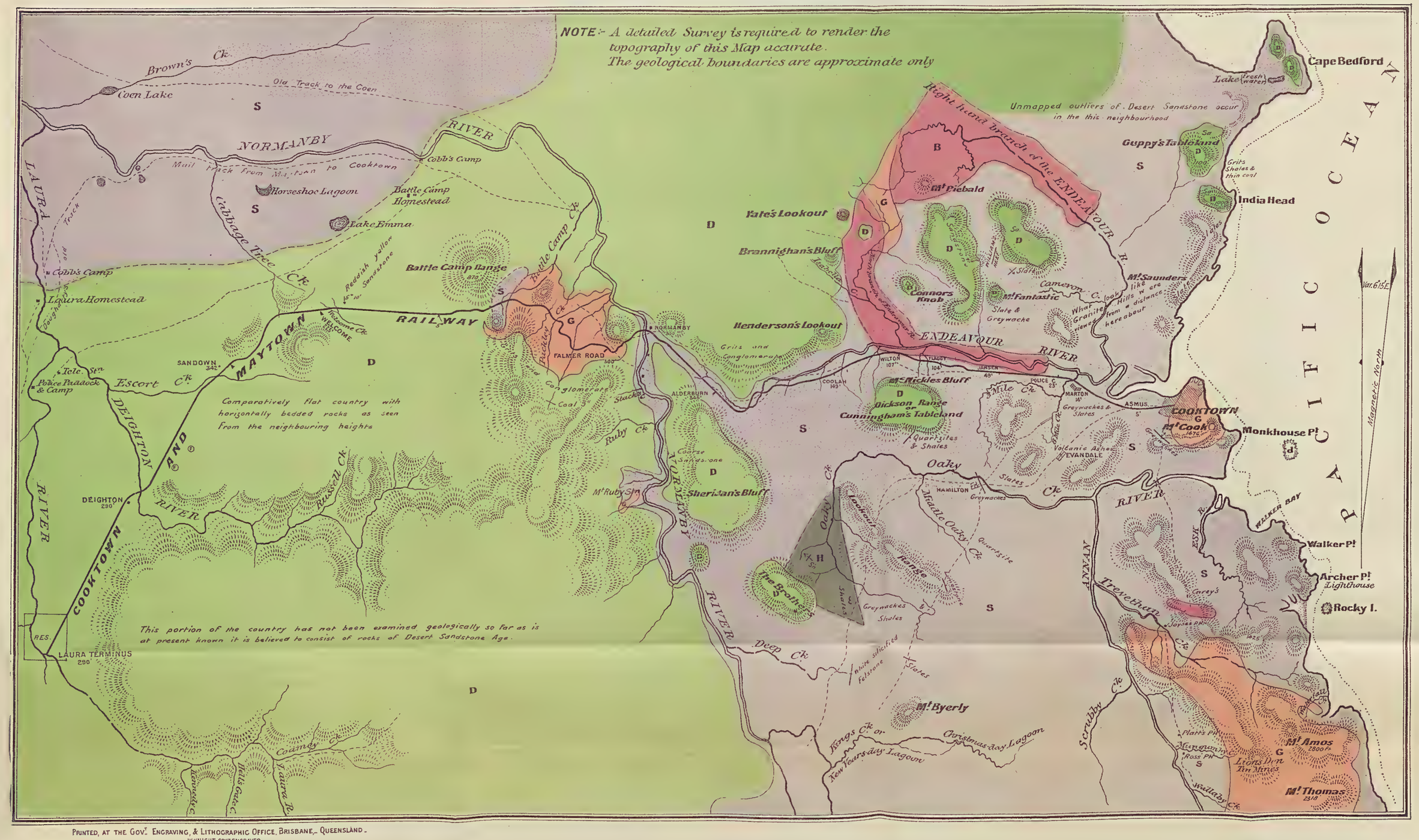
A. GIBB MAITLAND,
Assistant Geologist.

Price 2s.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND

GEOLOGICAL SKETCH MAP
OF
THE COOKTOWN DISTRICT



PRINTED, AT THE GOVT. ENGRAVING, & LITHOGRAPHIC OFFICE, BRISBANE,- QUEENSLAND.
W. KNIGHT, GOVT. ENGRAVER.

Scale 4 Miles to an Inch

4 2 0 4 8 12 16

INDEX OF COLOURS AND SIGNS.

Slates and Schists (Age undetermined)	S	*Bowen River Beds* (Permo Carboniferous)	H	*Desert Sandstone* (Upper Cretaceous)	D	*Basaltic Lavas* (Post Cretacous)	B	*Granite*	G

15 Dip from observation the figure represents the amount. (F) *Fossils.* + *Strike of strata when vertical.* + *Strike of strata when nearly vertical.*

Horizontal Sections to accompany

Report on

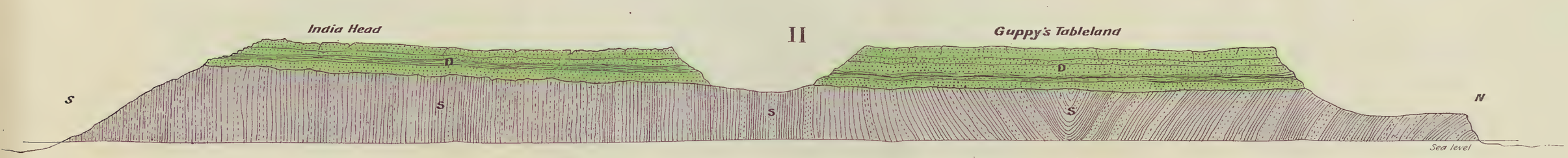
THE GEOLOGY OF THE COOKTOWN DISTRICT

I

Section from the Head of the Endeavour River to Welcome Creek.

Horizontal and vertical scale one inch per mile.

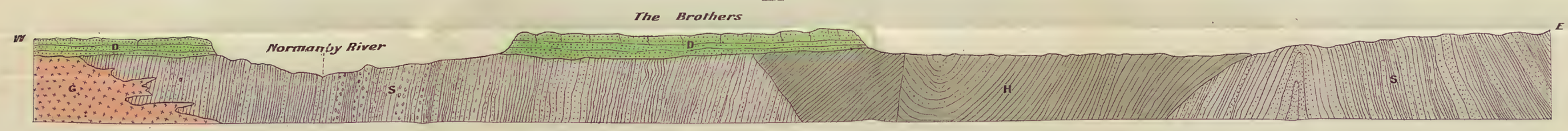
II



Section across India Head and Guppy's Tableland.

Horizontal and vertical scale six inches per mile.

III



Generalized Section across Oaky Creek Coalfield.

Horizontal and vertical scale six inches per mile

INDEX OF COLOURS

Slates and Schists (Age undetermined)	S	*Bowen River Beds* (Permo Carboniferous) Sandstones, Shales & thin Coals.	H	*Desert Sandstone* (Upper Cretaceous)	D	*Granite* (Age undetermined)	G

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NATIONAL MUSEUM VICTORIA

1891.

QUEENSLAND.

GEOLOGY AND MINERAL RESOURCES OF THE UPPER BURDEKIN.

(REPORT BY A. GIBB MAITLAND, ASSISTANT GEOLOGIST, ON THE)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

The following Report is intended to describe the general geological features of that tract of country drained by the upper reaches of the Burdekin River and its tributaries, embracing an area of about 8,000 square miles.

This Report is accompanied by sketch map, upon a scale of eight miles to the inch, upon which the geological boundaries are approximately depicted. The geological features of the portion to the south of the Burdekin are taken from a traverse made from Table Mountain, a hill on the divide between the waters of the Einasleigh and the Burdekin to the Continong, by Mr. R. L. Jack, and described in his report on "Geological Observations in the North of Queensland" in 1887.

To carry out a complete geological survey of a tract of country so extensive, in the short space of time that could be devoted to the work, was found to be quite impossible. The only practicable method in such a case was to traverse sections along the main roads or tracks where the geological boundaries could be marked with such a degree of accuracy as the topography would allow, and then to join on the boundaries approximately.

The Physical Features.

The district in question is an elevated plateau with an average altitude of about 1,500–1,600 feet above the level of the sea.

The table-land rises from the flats facing the sea, with a fairly steep slope, and forms a conspicuous escarpment—the Coast Range—indented with river valleys and drainage channels of all dimensions.

These coastal flats do not attain any great elevation above the level of the sea; they seldom exceed an altitude of 100 feet. Across these flats flow the numerous creeks, which take their rise on the seaward face of the tableland.

The coast range itself has no mountains which attain any great altitude. The general contour consists for the most part of a few isolated peaks and ridges made up of granitic rocks.

Once the plateau is reached and viewed from a lofty point of vantage—Mount Fox, a peak 2,870 feet above the sea-level, and a conspicuous landmark for miles around—it is found to consist as a whole of a plain studded with numerous rounded hillocks, and diversified here and there with a few isolated groups of mountains, the Blue Range, &c. To the westward, however, the numerous conical peaks of the lava plains on the divide between the Einasleigh and the Burdekin stand out in bold relief.

There are minor ranges, the Pelican Lake Range and the flat-topped range dividing the waters of the Herbert from those of the Burdekin; but as seen from any commanding eminence these smaller ranges do not materially interfere with the impression of a gradually sloping plain.

The Blue Range, the most conspicuous and ruggid within the area, which it is the object of this Report to describe, occupies that triangular tract of country bounded on the south by the Burdekin, on the north-east by Tomahawk or Packsaddle Creek, and on the west by Camel Creek. The range is deeply furrowed by tributaries of the Burdekin and the two creeks above mentioned, and is formed of a series of castellated peaks of coarse sandstone. The highest summit, capped with coarse grit, having a vertical escarpment 130 feet in height on the south-west, attains an estimated altitude of 2,670 feet above the level of the sea.

To the north, as far as the eye could reach, the country appeared to be a fairly undulating timber-covered plain, the only conspicuous summits visible being the two volcanic hills, Mounts Dora and Jimmy. Mount Razorback, one of the highest points on the basaltic tableland, near the divide between the Burdekin and the Einasleigh, attains an elevation of about 3,000 feet above the level of the sea.

By many residents in the district this has long been and still is known as Mount Lang, under the impression that this was the mountain named by Dr. Leichhardt. From a description given by him in his "Journal of an Overland Expedition in Australia from Moreton Bay to Port Essington in 1844-1845," it appears that on May 5th, 1845, he discovered "a blue mountain," which he named after "Dr. Lang, the distinguished historiographer of New South Wales." From the context it is seen that this mountain is in the watershed of Reedy Brook, and apparently not far from its head.

On

On May the 10th, in describing Ant-Hill Creek, mention is made of a series of open plains, one of which "came from Mount Lang" and another from an isolated razorbacked hill. In the headwaters of the Burdekin there is only one "isolated razorbacked hill," and that is the one marked on the maps as Mount Razorback.

On the 14th of May Leichhardt "started early in the morning, and passed between Mount Lang and Razorback Hill." On reading his journal it appears that Razorback Hill is drained by the waters of Ant-Hill Creek.

The watersheds are two in number. The principal one is that which divides the Herbert and the coastal waters from those of the Burdekin, and the other is that which divides the waters of the Burdekin from those flowing into the Gulf of Carpentaria.

To the south the first goes by the name of the Main Coast Range, to which, northwards, the term Seaview Range is given.

Its general trend is north-north-west, and it is crossed by the Cardwell Road from Herbert Vale Station, at an altitude of 1,800 feet above the alluvial flats along the bank of the Herbert, or about 2,000 feet above sea-level; and by the bridle-track from Lake Lucy Station to Cashmere, at an estimated altitude of 800 feet above the banks of the Herbert River.

The second, which is marked on all the existing maps as a conspicuous mountain range, is formed by the basaltic plateau described below. No conspicuous range divides the eastern from the western waters in this area.

The whole of the country described is drained by the Burdekin River and its tributaries, and on the whole is well watered.

The river rises near the summit of the Main Range, in two streams, the north fork and the south fork.

There appears to be some little difficulty in deciding as to which of the two creeks is the main head of the river. After emerging from the recesses of the Main Range the river flows for about 200 miles over open well-grassed undulating country. The whole of the Valley of the Burdekin is nowhere very steep, nor are there any noteworthy waterfalls or cascades in the main channel course, owing doubtless to the very gradual slope of the valley. Above where the river emerges from the Main Range its course generally is through a rockbound valley, occasionally opening out into flats of varying extent.

In its course, from its source to the Continong, there occur five marked bends.

The first change after flowing in a general north-easterly direction for about 30 to 40 miles is met with in that tract of country about 12 to 14 miles west of Wairuna Station; here its course alters somewhat abruptly, and flows west-south-west for about 30 miles until it is joined by Glendhu Creek. At this point the river makes a right angle, and flows generally south-south-west through extensive flats, studded with lakes and lagoons, until the Dry River enters it from the north-west. Here the direction of the river changes gradually easterly, and flows on until it is joined by Camel Creek from the north; after which it takes a course almost due south for about 8–10 miles.

Near to where the river passes Christmas Creek Station its course is altered to nearly south-west, which direction it maintains with many bends of more or less importance until it flows past the Continong.

Lucy Creek, Ant-Hill Creek, Reedy Brook, the Dry River, Grey Creek, Hopewell Creek, Christmas Creek, Camel Creek, the Clarke River, the Douglas River, Oakey Creek, and the Running River are the most important affluents of the Burdekin.

There are numerous other minor tributaries, but as no topographical survey has as yet been made only the main drainage channels can be shown on the map.

Lucy Creek rises about 20 miles east of its junction with the Burdekin, at an elevation, by aneroid, of 650 feet above Lake Lucy Station. It flows over fairly open country, and when nearing Lake Lucy loses itself in swamps and lagoons, so that its actual course is somewhat difficult to trace. Lake Lucy, after which the creek takes its name, is one of these lagoons, of somewhat greater dimensions than usual.

Ant-Hill Creek takes its rise to the west of Mount Razorback, on the basaltic plateaus separating the waters of the Burdekin from those of the Einasleigh, at an elevation of about 1,200 feet above the Valley of Lagoons Station.

The name Casaurinas Creek was given by Dr. Leichhardt in 1845 to the lower portion of the creek, from the fact that numerous Casaurinas fringed either bank; but, on following the creek up, "in consequence of numerous gigantic strangely buttressed structures of the white ant" he called it "Big Ant-Hill Creek."

Throughout its whole course this creek drains several extensive open plains, "the largest of which," says Leichhardt, "was from 12 to 15 miles long and from 2 to 3 miles broad, came from Mount Lang; another plain came from an isolated razorbacked hill" (Mount Razorback). These plains are at present known as Walter's Plains.

Glendhu Creek I had no opportunity of visiting, so that I am unable to give any description of it.

Reedy Brook is formed by the junction of Expedition and Kinrara Creeks. These two creeks take their rise on the plateau at an elevation of about 1,000 feet above the junction of Reedy Brook with the Burdekin.

Throughout their whole length they flow over basaltic country of well-nigh undescribable roughness, but interspersed with a few open black-soil flats, producing a luxuriant growth of vegetation much relished by stock. Below the junction of the two creeks, Leichhardt, in his diary, describes the valley of Reedy Brook as "a level sheet or flow of basalt, here and there covered with a very shallow soil, but sometimes bare, though clothed with a fair supply of grass and scattered with flooded gum trees;" and again he says that the "lava is hollowed out into numerous deep basins in which water collected and formed the lagoons."

The Dry River, Grey Creek, and Hopeful Creek were not visited, hence it is impossible to give any description of the features of the country through which they flow.

Camel Creek I take to be the one named by Leichhardt the "Perry" River, out of compliment to Captain Perry, the Deputy Surveyor-General of New South Wales. That Camel Creek is the same as the Perry is, I think, evident from the following quotation from Leichhardt's Journal of an "Overland Expedition in Australia from Moreton Bay to Port Essington:"—"April 24th, 1845. To-day we travelled along

along the river (the Burdekin) over an open country, intersected by some gullies; the course of the river was for about four miles from north to south, and at that distance from our camp was joined by a river coming from the northward. . . . . .

"The Burdekin here comes from the westward, and made a large bend round several mountains . . . . . ." Camel Creek rises in the country almost surrounded by the Burdekin, not far from one of the tributaries of the river, flowing northwards. It has two important affluents, and below their confluence the creek takes a general southerly course.

The Douglas River is an important tributary, the head of which is reputed to rise but a very short distance from the actual source of the Burdekin. From its source to its junction with the main river it flows over country very variable in its features. In the upper portion of its course it is rock-bound for some distance, and in one place an important affluent, which drains the country in the neighbourhood of Mount Fox, has carved out for itself a narrow and lengthy cañon about fifty to sixty feet in depth through compact basalt and granite. A few miles south of Kangaroo Hills Station the Douglas is joined by Tomahawk or Packsaddle Creek, some of the tributaries of which drain the north-east flank of the Blue Range.

The two remaining tributaries of the Burdekin, Oakey Creek and the Running River, take their rise at or near the summit of the main range, at altitudes of about 2,500 feet above the level of the sea, and find their way to the main river over rough and rock-bound country for a considerable portion of their course.

THE GEOLOGICAL FEATURES.

The earliest writer to give any description of the geological features of the Upper Burdekin was Dr. Leichhardt. He, in a journal kept during his overland expedition from Moreton Bay to Port Essington in 1844-45, and published in 1847, makes mention of those geological facts which appeared to him of importance. The late R. Daintree, at one time Government Geologist for North Queensland, in his "Notes on the Geology of the Colony of Queensland," published by the Geological Society of London in 1872, has merely a few lines dealing with this portion of the Colony, viz.:—". . . . The dense lavas of the Upper Burdekin (volcanic outbursts of a late Tertiary epoch) are traversed by valleys of erosion, in some cases 200 feet deep and 5 miles broad."

There is nothing in the context to show what is meant by the term "Upper Burdekin"; but during my examination of the lava fields no valleys of erosion 200 feet deep and 5 miles broad were met with.

A short account of a traverse made from Table Mountain to the Continong in 1887, by Mr. R. L. Jack, Government Geologist, has been embodied in his "Geological Observations in the North of Queensland," published in 1887.

The basaltic plateau near the Valley of Lagoons Station is mentioned by Dr. Carl Lumholtz in his work "Among Cannibals," published in 1890. He merely states that the vicinity of the Valley of Lagoons Station "is a large district covered with lava in which are many caverns serving as hidingplaces for the savages . . . . . "

The Geological Systems developed in the Upper Burdekin, so far as is at present known, consist, in descending order, of—

(D) Desert sandstone—Upper Cretaceous.
(M) Star Beds—Lower Carboniferous.
(R) Burdekin Beds—Devonian.
(S) Schistose Rocks of undetermined age.
(B) Basaltic Lavas—(Tertiary?)
(G) Granitic Rocks } of undetermined age.
(P) Acidic Lavas }

(D) Desert Sandstone System.

Throughout the district at all elevations there occur isolated fragments of reddish-coloured sandstones and conglomerates, which are provisionally regarded as being Desert Sandstone age. Nowhere were they found to contain any fossils; nor was there any great thickness of them visible in one section.

The first exposure of these rocks is met with in the country drained by the heads of Oakey Creek, at an altitude of about 2,300 feet above the level of the sea. Here the rock consists of an angular quartzose grit, which further south passes into a brecciated conglomerate.

Lower down the creek, near its junction with the Burdekin, a series of well-nigh horizontal conglomerates and grits is crossed by the track from Kangaroo Hills Station to Donnybrook; a conspicuous escarpment of a higher member of the series can be traced by the eye for a considerable distance east and west.

Near the head of one of the branches of the Douglas River a similar series of angular grits and conglomerates is seen to overlie the granite. The area occupied by these rocks is far too small to be shown on the accompanying map.

On the road from Townsville to the Etheridge, several isolated fragments of desert sandstone have been noticed and described by Mr. Jack in 1887.

A low tableland of ferruginous sandstone caps the divide between the Einasleigh and the Burdekin, to the north of the Townsville and Etheridge road. Near Doughboy Creek (not shown on the map) "soft red ferruginous desert sandstones and conglomerates make their appearance in cliffs about fifty feet high." "The pebbles of the conglomerate are mainly of the brown and yellow sandstones seen on the road to the west."

Patches of desert sandstone are met with at intervals, on the south side of the Burdekin, between Doughboy Creek and the Continong.

The road from the crossing of the Burdekin, near Greenvale Station, to the Valley of Lagoons is flanked on its western side with tables of red sandstone, which doubtless belong to the desert sandstone system.

In the vicinity of the Valley of Lagoons Station these rocks form well marked escarpments, running up to the heads of minor gullies, which empty themselves into the lagoons with which the eastern bank of the Burdekin is studded. In one place these rocks are seen to consist of brecciated conglomerates, made up of large subangular fragments of quartz and mica schist set in a reddish-brown sandy matrix. These rest upon the upturned edges of the quartzites, schists, &c.

A creek

A creek entering the Burdekin from the west exposes in a cliff on its northern bank a bed of conglomerate, similar to that above described, resting upon schists, and covered by a compact basalt sheet as depicted in Section I., plate 1.

The divide between the Herbert and the Burdekin is capped by horizontal beds of friable ferruginous sandstone, derived apparently from the denudation of granitic rocks; these rest alternately upon acidic lavas and granite as shown in Section II., plate 1.

In Blackwater Creek, a tributary of the Burdekin (not shown on the map), what are taken to be representatives of the desert sandstone make their appearance on either bank of the river, and are seen to rest upon granite as in Section III., plate 1. From this section it appears that the desert sandstone beds were laid down in the already denuded Burdekin Valley.

Coarse ferruginous conglomerates or breccias, in the more immediate vicinity of Wairuna Station, rest upon the vertical edges of the slates, &c., which make up a large portion of the neighbourhood. On the south side of the Burdekin, between Wairuna and Lake Lucy, these desert sandstone rocks are well developed; they often form conspicuous cliffs of no great height, which can be followed by the eye for some distance.

The bridle-road from Wairuna to Lake Lucy crosses a tableland of ferruginous sandstone for about four miles in a southerly direction. The southern face of this is made up of a very red ferruginous grit, the material cementing the quartz grains being an earthy hæmatite.

From Oakhill Station to the summit of the main coast range several exposures of ferruginous sandstones are met with on either side of the road. These present a considerable lithological resemblance to those beds which cap the Main Range in the vicinity of the Kangaroo Hills Tinfield.

The occurrence of fragments of these cretaceous rocks throughout the whole of the Upper Burdekin seems to indicate that they originally occupied a very extensive tract of country. That their thickness must have been considerable is evidenced by the fact that their base occurs at all elevations above the sea level. Taking the lowest elevation (near the mouth of Oakey Creek) at which these beds are met with as being 1,300 feet, and the highest elevation of their base as being 2,200 feet above the sea, there cannot have been less than 900 feet of them; how much more, it is at present impossible to give any idea.

(M) Star Beds.

It is with hesitation that I class a series of grits, sandstones, and conglomerates, occurring in the south-east corner of the country with the Star Beds. No organic remains were detected in any of them. It is only their strong lithological resemblance to strata of that age in other areas that gives any clue to their geological position. They do not occupy a very extensive tract of country.

The first locality in which these beds were met with is about north-north-east of Kangaroo Hills Station, and distant about eight to ten miles. They consist of coarse whitish quartzose grits and conglomerates, lying almost horizontally and forming conspicuous escarpments, traceable for some distance; they rest alternately upon granite and the upturned edges of a series of hardened grits and shales, which have a general north-east and south-west strike. Sect. IV., plate 1, gives a general idea of their occurrence. Some little distance from Mount Fox to the north, about ten feet thick of a whitish quartzose grit resting on granite and dipping at 70 degrees north-east is seen to be overflown by sheets of basaltic lava. Much lower down the creek, boulders of grit were seen, but this is the only section where the rock is met with *in situ*. The section is shown Sect. I., plate 2.

An extensive development of these beds is to be seen in the Blue Range, which occupies that piece of country drained by the tributaries of Tomahawk or Packsaddle Creek, Camel Creek, and some minor affluents of the Burdekin. In a traverse from the camp on Tomahawk Creek to the Blue Range the country was found to consist of shales and ferruginous felspathic sandstones or greywackes, in which no fossils were detected. These beds are nearly vertical, and strike north-east and south-west.

The sedimentary strata which rest unconformably upon the vertical beds are arranged in the form of a synclinal trough, the longer axis of which appears to trend in a north-westerly direction. Scaling the first cliff formed by the denudation of the Star Beds, the quasivitreous white sandstones were found to dip south at angles of about 35 degrees; the trend of the mural precipice was east-south-east. The actual summit was ascertained by aneroid to be 2,030 feet above sea-level. This mountain is almost isolated from the main mass of the range by a low saddle 1,620 feet above sea-level, and which divides waters flowing east and west. In this low saddle vertical ferruginous felspathic grits striking north-east and south-west crop out at intervals. After passing over a low table of grit, beneath which the vertical sedimentary beds are seen to lie, a hill 1,930 feet above sea-level was ascended and found to be capped with grits which were seamed in places with veinlets of quartz. At the foot of the hill in the north-east these beds appear to be faulted against the vertical shales and greywackes. The highest point of the range was found to be 2,670 feet in height, and composed of coarse grit and conglomerate, with a vertical wall-like precipice over 100 feet in height facing the south-west. (Section II., plate 2.)

From this point the general character of the range could be well seen, and its geological structure. Owing to darkness coming on I was unable to visit the south-westerly end of the synclinal trough.

Another minor area of what are regarded as representatives of the Star Beds is met with in the vicinity of Lake Lucy Station. Some distance west from the head station a conspicuous low hill is seen to be composed of a semivitreous white grit or quartzite, which appears to unconformably overlie the Wairuna Beds.

A gully flowing south-west from the divide east-south-east of the station, and about three miles distant from it, another section showing a similar grit or quartzite is seen in a cliff which trends north-east and south-west.

The area occupied by these beds is far too small to be shown on the map.

(R) Burdekin Beds. (Devonian.)

The series of strata classed under this head occupy a very extensive tract of country.

The basin is bounded on the west by a belt of schistose rocks of variable width, and on the north and west by the granitic rocks which make up the main coast range. Small patches of schistose rocks, however, are seen near the tin lodes at Kangaroo Hills, separating the Burdekin beds from the granite, but of too small an area to be shown on the map.

It has been found impossible to examine the whole of the country occupied by these beds, but sufficient data have been gathered to enable a fair idea of the general character of the rocks of the basin being obtained.

In their lithological characters they present a marked contrast to the rocks above and below them.

The strata consist for the most part of dark-buff and reddish-coloured shales, sometimes jasperised, together with grits, greywackes, and quartzites generally inclined at high angles. The thickness of these beds, unless repeated by folding, must be very great.

From their lithological characters it appears possible to divide them into two subdivisions, one consisting for the most part of reddish shales and ferruginous chocolate-coloured sandstones, and the lower of dark shales, grits, and greywackes. From the fact that these reddish beds were first seen near Wairuna Station, for convenience of description I have named them the Wairuna Beds.

From the Four-mile Creek—a tributary of the Douglas—to Kangaroo Hills Station the gullies show buff-coloured vertical shales and greywackes, striking generally east and west.

The eastern bank of the river at Kangaroo Hills Station is composed of buff shales and greywackes, which dip at an angle of 80 degrees to north 70 degrees west, and strike north 30 degrees east.

Near the tin lodes the "Star Beds" are seen (Sect. IV., plate 1) to rest upon a series of highly inclined hardened grits and shales. In close proximity to the granite, beds hardened and metamorphosed are met with; to ascertain whether these are representatives of the Burdekin bed more highly altered, or are of older date, would require much more detailed work than is possible in a flying *reconnaissance.*

From Kangaroo Hills Station to the mouth of Camel Creek the country is occupied by vertical shales of a somewhat similar type to those above described. In Tomahawk Creek they strike west 20 degrees south. Between this point and the crossing of the Douglas the sedimentary strata are intersected by a tongue of granite.

From the mouth of Camel Creek to a gully about two miles further down the river the country is made up of vertical contorted shales and greywackes; at the south end of the section their strike is north and south, at the mouth of Camel Creek it has veered round to west-north-west.

A few low hills of flaggy grits, dipping at angles of from 25 degrees to 30 degrees to the northwards, are passed over in traversing the country from the mouth of Camel Creek to a point on the opposite side of the Burdekin to Greenvale Station.

To the Valley of Lagoons Station comparatively few sections are to be seen owing to extent of flat country covered with recent superficial deposits. At one place about five or six miles north of Greenvale Station, ridges showing vertical sandstones striking north-east and south-west occur. These bear a strong lithological resemblance to those last described. Similar beds underlie the flats for the next few miles, then their place is taken by reddish jasperised shales.

The relation of these shales to the sandstones is not very clear, but I am inclined to regard them as being separated by a fault.

Further northwards along the road the eye is attracted, even at a distance, by a conspicuous cliff about 100 feet in height. On nearing it the western face was found to be full of caverns of no great size, and the base was strewn with huge boulders of rock. The matrix of which this hill is composed is a quartz rock generally with a reddish tinge, though sometimes white. It appears to be bedded, the bedding planes being nearly vertical and striking north and south. Some of the weathered surfaces suggest a volcanic origin (ash?).

Underlying the flats of the next mile or two are shales, &c., dipping at 25 to 30 degrees to the north-east.

The country to the east of the station at the Valley of Lagoons is occupied by fine-grained sandstones of a yellowish-brown or buff colour. In some places the sandstones are crowded with sun cracks.

They rest unconformably upon the schists, and dip to the south-east at angles varying from 70 to 30 degrees.

They do not form any important feature in the landscape.

In the vicinity of Wairuna Station, vertical shales of a reddish-purple colour strike north and south, some of which look not unlike fine volcanic ashes. At one place west from the station some of the shales are found to be associated with thick beds of quartzite; these strike north-east and south-west. The Wairuna Beds are seen cropping up at intervals along the track to Lake Lucy Station.

The environs of Lake Lucy are made up of reddish clayey shales, identical with those above described, and having the same general trend—viz., north-east and south-west. Interstratified with these shales are bands of limonite intermingled with veinlets of quartz. These bands are not continuous for any distance. All of these examined were parallel with the bedding planes, and of very variable thickness. A few quartz reefs intersect these shales. Between Lake Lucy and Dak Hills the Wairuna Beds occupy the country; they retain the same character and strike. Unless repeated by faulting and folding (which is not improbable) these Wairuna Beds must be of enormous thickness.

Among the rocks above described there may be beds which future detailed mapping may prove to belong to other systems.

At present, in the absence of palæontological or stratigraphical evidence, the whole beds are provisionally classed as belonging to one system.

(s) Schistose Rocks. (Age undetermined.)

Throughout the area occupied by these, schistose rocks bear very much the same general characters. For the most part they are mica schists with quartzites and quartz schists, in some places very much contorted.

The ridge upon which the Valley of Lagoons Station stands is made up of highly inclined mica schists striking north-east. To the east of the station the mica schists are interstratified with quartzites and quartz schists. On the eastern bank of the Burdekin, about a mile below the station, the rocks open to observation are mica schists, which are often "wavy and contorted"; they have all the appearance of having been originally micaceous flaggy sandstones. These beds form a bar crossing the river, and produce a series of picturesque rapids. Lenticular "eyes" or patches of quartz of all dimensions, having a tendency to follow the planes of foliation, can be seen in them. Sometimes the quartz seems to assume the form of segregation veins, transverse to the foliation.

Some

Some distance higher up the river these schists dip at an angle of 45 degrees to the north-east and strike north-west and south-east.

These schists pass beneath the lavas of the volcanic plateau, and emerge at Cashmere Station.

In a creek flowing north-east into the Herbert River, about ten to twelve miles from Cunnawarra Station, vertical micaceous and hornblendic schists with contorted bands of quartz are overlain by a sheet of basaltic lava. The schists strike south 10 degrees east.

(B) Basaltic Lavas. (Tertiary.)

The basaltic lavas occupy an area of about 2,000 square miles at the head of the Burdekin.

The largest development occurs in the corner near the divides between the waters of the Burdekin and the Einasleigh, and between the Herbert and the Burdekin; they form an extensive plateau, having an average altitude of about 2,000 feet above sea-level. The western boundary of this immense plateau has not yet been mapped.

Basaltic outflows are known to exist at Surprise Creek, a tributary of the Einasleigh. These which emanated from focii, on the Burdekin-Einasleigh Plateau, are crossed by the coach road from Herberton to Georgetown, near Quartz Hill. This is distant about 40 miles from the watershed of the Burdekin and the Einasleigh.

The northern boundary has also not been delineated. Streams of lava have flowed down some of the existing valleys in the neighbourhood of Cunnawarra Station, and have been described in a previous report.* Doubtless the hot spring therein described is but the "dying gasp" of that volcanic action which was at one time rife in this district.

In addition to this immense plateau there occur other isolated patches in the district shown on the map. These lavas since their formation do not appear to have been very much affected by denudation.

The basalt of which the tableland is made up occurs in a series of superimposed lava flows emanating from numerous volcanic focii, which rise as conspicuous hills all over the plateau.

The surface of these lavas is in places formed of "chaotic heaps of angular blocks of basalt, tossed in every variety of disorder," rendering locomotion a matter of some considerable difficulty, especially with horses. Generally the surface produces a luxuriant growth of vegetation, well suited for and much relished by stock. The more rugged surfaces of some of the more recent flows are covered with bottle-tree scrub.

On the other side of the Burdekin west from the Valley of Lagoons Station the surface of the lava flows are full of dismal-looking deep pits of all dimensions in which water often accumulates.

The formation of these pits appears to be due to the caving in of the surface of a lava stream.

The surface of a lava stream flowing from one of the volcanic focii cools and hardens, whilst the molten matter flows from beneath, leaving a tubular cavern; in course of time a portion of the hardened surface gives way, and a pit with vertical sides is the result. These caverns can sometimes be followed for a considerable distance; they form excellent hidingplaces for the natives.

Water can often be seen and heard flowing at the bottom of these holes. Many of these large holes filled with water are met with on the divide between the Herbert and the Burdekin.

In the whole of the area examined there was found no trace of any fragmental rocks associated with the basaltic outflows. It is conceivable that denudation may have removed all trace of the more incoherent material ejected; but still it is hardly likely that in an area of 2,000 square miles there would not be some fragments left.

Professor J. D. Dana† in the course of his studies in Vulcanology has concluded that basaltic lavas are but rarely associated with fragmental deposits (ashes, cinders, and the like). When such discharges do take place they are usually occasioned by the diminution of the internal heat. Hence it would appear that ashy deposits from basaltic volcanoes are among the last stages in their history.

In the Cooktown and the Herberton Districts there do occur beds of ashes which emanate from basaltic cones, but whether these are of later date than the Burdekin-Einasleigh lavas yet awaits proof.

Throughout the area occupied by the lavas there is a very great difference both in texture and colour. Some portions are very vesicular and saggy, whilst others have that peculiar "ropy" or wrinkled appearance characteristic of lava streams which have flowed slowly from their source; others again are fairly compact. In colour they vary from bluish-grey to bright-red, with all degrees of variation. In cavities in the basalts beautiful specimens of chalcedony can sometimes be seen.

The black soil formed by the decay of the rocks is often crowded with fragments of semi-opal.

A number of slices of the basalts have been prepared and submitted to microscopic examination.

A partial analysis of a specimen from the Valley of Lagoons has been made for me by Messrs. Coane and Clarke, Charters Towers, with the following result :—

Combined Silica	43·8 per cent.
Free Silica	6·7 „
Iron (estimated as F_2)	13·5 „

One example—viz., that from Mount Razorback—would be more correctly described as a magma-basalt, from the fact that the minerals are scattered through a glassy matrix or magma, which by ordinary transmitted light is of a brownish colour.

This, however, is merely a local occurrence; a few yards distant from the summit of Mount Razorback the basalt resumes its ordinary type.

The felspars, which make up the larger portion, occur as long lath-shaped crystals, showing plagioclastic twining.

They are remarkably clear and fresh, and contain numerous minute inclusions.

Olivine, in crystals and crystalline grains, is altered along its edges into a ferruginous product. Sometimes the whole of the crystals and grains have undergone this alteration, but generally the decomposition is found to extend only a short distance from the periphery.

The augite occurs in long brownish crystals often showing faint dichroism and magnetite in grains.

In

* "The Geology of the Coolgarra Tin Mines and Surrounding Districts."—A. Gibb Maitland. Brisbane: By Authority, 1891.

† J. D. Dana, "Characteristics of Volcanoes," London, 1890.

In the slices of any of the basalts which were examined there occurred a little clear transparent isotropic matter.

Some portions of the glassy matter contain minute particles of some doubly refracting mineral (quartz?).

The partial analysis made by Messrs. Coane and Clarke shows the presence of a small quantity of free silica, and to this the isotropic matter may be referred.

There existed no primary quartz in any of the slices of these basalts.

All over the plateau many numerous small "puys," the remains of orifices from which these basaltic lavas emanate, are met with.

Ascending the Valley of Reedy Brook to its head, and crossing the divide into the waters of Cunnowarra Creek, a tributary of the Herbert River, a good idea of the mode of occurrence of the lavas and the structure of the volcanic focii can be obtained.

Much more work will be necessary before a full description of the whole of sources of the lava on the plateau can be obtained.

Mount Lang is situated on the eastern bank of one of the heads of Kinrara Creek; its summit is about 440 feet above its base. The hill presents a steep face to the west with a somewhat gradual slope to the east, and is formed of very vesicular basalt which sometimes has a reddish hue. Its western face has a vertical wall of bare basalt, through which fragments of scoria are scattered. Round about the base the fragments of basalt have a tendency to weather into rudely hexagonal blocks.

Leaving Mount Lang and travelling almost due north, with the object of reaching Mount Razorback, several minor puys are passed. These were only visible when in close proximity owing to the dense timber.

About three miles from Mount Razorback, and to the south-west of it, a conspicuous hill formed of vesicular basalt was examined. This hill is in shape semicircular, with its diameter running north-west and south-east. It is a breached lava cone, the stream flowing north-east from it and thence down one of the heads of Anthill Creek.

Mount Razorback is situated in the northern portion of the area, and is by far the largest and most conspicuous of any of those occurring within the Burdekin watershed.

Its shape is that of a long razor-backed ridge, with a conspicuous eminence forming its highest summit, which by aneroid is 680 feet above its base. The mountain is composed of basalt of a reddish colour near its highest point, but of a bluish-grey throughout.

The basalt is very vesicular and somewhat glassy in places. From the summit as many as twenty-five minor puys are visible; these appear to be much more plentiful to the west. They assume all shapes and sizes; sometimes merely a slight elevation marks their position, as though the molten matter had merely oozed out from an orifice and flowed away on all sides.

In other parts of the district outlying patches of basaltic lavas are met with.

A well-marked area is to be seen in the vicinity of Mount Fox, near the head of one of the tributaries of the Douglas River.

Mount Fox, an extinct volcano, is the culminating point of this area.

Its altitude is 2,870 feet above sea-level. In shape it is a truncated cone. The summit comprises an area of two or three acres, surrounded by a low semicircular wall about 13 to 14 feet in height on the north with a shallow hollow or depression in the centre. To the south this wall has been breached by a lava which flowed down that side of the mountain, filling up all the inequalities of the surface and forming a plain of no inconsiderable extent.

The mountain is almost devoid of timber, save a few patches of scrub on four sides. The portions devoid of timber are covered with sheets of vesicular lava, now broken up into blocks of all shapes and sizes. These timberless portions, now overgrown with long grass reaching to a height of about two feet, mark the site of old lava flows.

From the western side of the peak a conspicuous flow follows the eastern bank of a gully flowing south-west, at a considerable elevation above the creek. The flow ends abruptly to the south-west; its surface is covered with blocks of compact basalt.

All round the mountain denuded tables of basalt can be seen.

A conspicuous one consists of a semicircular ridge of compact lava, about 30 yards in width, trending generally north-west for about a quarter of a mile. The summit of this is about 2,310 feet above the level of the sea.

Nearly due west from this a section (Sect. I., plate 2), at an altitude of 2,220 feet above sea-level, shows the basaltic lavas resting on a bed of quartzose grit.

The hill, 2,475 feet high to the south-west of the section, is formed of a series of successive sheets of lava.

It is impossible to estimate the thickness of the basalt on the plateau, because there are no data available which will enable an idea to be formed as to what was the form of the ground before the lavas were poured out, and, further, there is no record of their ever having been penetrated by any excavation.

The age of these basaltic outflows has not yet been definitely fixed.

The lavas rest in turn upon all the other rocks in the district; one section seen near the Valley of Lagoons Station (Section I, plate 1) shows them resting directly upon the Desert Sandstone Beds. The basalts, therefore, are younger than the upper cretaceous.

Mr. R. Daintree conjectured (presumably on account of their lithological similarity) that the lavas to the "north of latitude 21 degrees were probably the equivalents of the 'Upper Volcanic Series'" of Victoria which were referred to Pliocene-Tertiary.*

Similar lavas in the Vegetable Creek District of New England, New south Wales, are referred by Mr. T. W. Edgeworth David to the eocene.†

Lithological similarity is not to be safely relied upon in determining geological age; still there is a strong presumptive evidence that all these basalts have been emitted at approximately the same time.

These Upper Burdekin lavas are in all probability tertiary, but as to the exact horizon to which they are to be assigned no evidence has yet been collected.

(6) Granitic

* Q.J.G.S., London, Vol. xxviii, p. 313.

† "Geology of the Vegetable Creek Tin Mining Field," p. 25.

(G) Granitic Rocks. (Age undetermined.)

In such an extensive area of granitic rocks it is quite natural to expect great variety, both in texture and composition.

Ascending the Coast Range from Ingham the granite consists of quartz, felspar, and hornblende—in some isolated places the latter mineral is absent.

The vicinity of the township on the Kangaroo Hills Tinfield shows granite containing a large proportion of crystals of othoclase, mica, and a little hornblende, together with the quartz. Dykes of felsite intersect the granite, but they do not appear to have any prevailing direction. At some places serpentine takes the place of the mica or the hornblende.

At the head of the Prospectors Creek a mass of felsite rock is observed; its composition is quartz, felspar, and hornblende in a flinty matrix. The weathered surface has a marked carious aspect.

The Three-mile Creek, a tributary of Prospectors Creek, drains a series of granite downs in which bands of fine-grained granite alternate with those of coarse. Near Mount Fox the granite is micceous.

South-south-west from Kangaroo Hills Station a low granite ridge is seen to be intersected by quartz reefs, many of them of large size.

Mount Dudley is another granite hill, south of Camel Creek, which, however, I had no opportunity of visiting.

The field relations of the granite has not been satisfactorily made out.

(P) Acidic Lavas and Ashes. (Age undetermined.)

A development of acidic lavas and ashes, which bear a certain resemblance to those of Croydon, the Newcastle Range, and Cleveland Bay, are met with near the divide between the Herbert and the Burdekin, north of Wairuna.

They are mainly fragmental rocks. Nothing was seen which would indicate their source, nor was their vertical thickness great.

Near the summit of the Coast Range, where it is crossed by the Cardwell road, is a large mass of felsite the relations of which to the surrounding granite were not made out. Probably it is a representative of acidic lavas.

Boulders of fragmental volcanic rocks are met with in many of the creeks on the coast at the foot of the Main Range, showing the continuation of these rocks.

These can actually be seen *in situ* near Stoneleigh Station on the Stone River; a well sunk near the house shows a weathered felsite with spheralitic structure. Similar rocks are met with at intervals in the creeks and hillsides in the vicinity of the Station.

These are doubtless the northward continuation of the lavas and ashes seen in Cleveland Bay and described in the report upon "The Physical Geology of Magnetic Island," and which are there associated with sandstones and shales. These sedimentary beds, which are interstratified with the lavas and ashes, have yielded *Glossopteris Browniana* and are regarded as being of permo-carboniferous age.

MINERAL RESOURCES.

The mineral resources of the Upper Burdekin are at present, practically, very little known. This in a measure is due to the great extent of country yet to be properly scanned (it is perhaps only possible for one who has had occasion to travel through it to realise the extent of comparatively unexamined area).

I visited in the course of my examination those portions of the district in which my work was going on, but no attempt was made to systematically "prospect"; to do this would entail months of labour.

Gold.—In the minds of miners for many years there has been a tradition that in the vicinity of Mount Lang a most valuable discovery of gold would one day be made.

This idea firmly rooted has gained currency from the fact that its origin has been erroneously ascribed to the late Rev. W. B. Clarke. No such statement, however, appears in any of his public writings.

The vicinity of Mount Lang, as has been stated above, consists of an immense series of basaltic lavas covering a very large extent of country.

These lavas, of a comparatively recent date, were emitted from numerous orifices, the remains of which now exist; they flooded the country for miles; covering many of the existing watercourses in the course of their passage.

That these watercourses contained alluvium in which quantities of gold existed is more than probable.

The course of these old river channels is not now very evident, and the thickness overlying basalt is not known.

To "prospect" the basalt careful examination of the streams flowing from beneath it is the most satisfactory method of discovering of the auriferous alluvium.

Silver Lead.

A promising deposit occurs about 25 miles distant southwards from Kangaroo Hill Station at a place then known as Donnybrook, on the waters of the Running River.

The discovery is said to have been made by Mr. R. Moss, one of the present owners, when out on a prospecting trip in the year 1871, but until the year 1890 he took no steps to work the deposit.

At the time I visited Donnybrook in June of 1890, Mr. Moss was the only one in the field. Little or no work could be said to have been done; hence to examine the surface features was all that could be done. The deposit occurs amongst a series of quartzites and saccharine limestones, the age of which, in the absence of detailed mapping or fossil evidence, I would hesitate to fix. From such an examination as was made the limestones did not appear to occupy any very great extent of country, and the whole of the rocks appeared to have undergone a certain amount of faulting and disturbance, resulting in the production of fissures of variable dimensions in which the ores were deposited.

About

About half a-mile north of the camp at Donnybrook a shaft has been put down to no great depth upon a lode of galena of variable thickness. The hanging-wall is well-defined, while the foot-wall cannot be said to have yet been found. A greyish-blue limestone forms the hanging-wall. The course of the lode appears to be about north 20 degrees east. In the cap a little green and blue carbonate of copper cerrusite, with kernels of galena. The lead is said to assay about 5½ ozs. of silver to the ton.

A little to the north a similar galena lode had been opened up; this is said to assay 26 ozs. of silver to the ton. Very little work had been done at the time of my visit. The ore at the surface contains green and blue carbonates of copper, galena, and carbonate of lead. One of the walls is a white saccharine limestone which runs north 65 degrees east.

Close to Donnybrook, the most work appears to have been done upon a lode known as the *Hidden Treasure*. A shaft has been put down to a depth of 40 feet. No foot-wall appeared to have yet been met with.

The lode consisted of a large body of kaolin and lithomarge, containing small quantities of green carbonate of copper, some showing native silver fairly abundantly, and a little oxide of manganese (hausmannite?). A specimen from the surface, containing cerrusite and copper carbonates, assayed for me by Messrs. Coane and Clarke, yielded 314 ozs. 5 dwts. 1 gr. of silver and 19 per cent. of lead to the ton.

At the foot of the shaft galena was beginning to make its appearance at 45 degrees to south 60 degrees east. The galena, of fairly fine grain, yielded, on assay by Messrs. Coane and Clarke, 1 oz. 9 dwts. 9 grs. of silver and 28 per cent. of lead, with a trace of gold, to the ton.

Tin.—The only locality where tin has been extensively worked is the Kangaroo Hills Tinfield.

There is no map in existence showing the relation which the various claims and creeks on the Kangaroo Hills Tinfield bear to one another. The position of the township is approximately depicted upon the general map by which this Report is accompanied.

The larger portion of the stream tin workings exists near the confluence of Sandy and Prospectors Creeks—tributaries of Oakey Creek—at an estimated altitude by aneroid of 2,113 feet above the level of the sea.

At the time of my visit to the field in June, 1890, it was practically deserted. A few men were at work. In some cases the creeks and gullies were being "raked" for the second or third time.

The ore of tin obtained throughout the field is the binoxide cassiterite, which occurs in rounded fragments and broken crystals, generally of a reddish colour, and of no very great size. In some of the claims I saw a few of an amber colour, but they did not appear to be very common.

Along with the tin in the wash there were a few topazes and a little magnetite.

The wash dirt rests directly upon an uneven surface of granite.

A section of this is well seen in a claim, originally part of the old P.C., viz.:—

(a.) Stratified gritty sand, of a yellowish red colour, with a somewhat gravelly base, and varying in thickness from 10 to 14 feet.

(b.) Cement, the matrix being a clay of a bluish-white colour, though often stained yellow. Of this there are from 3 to 4 feet.

It is in this cement, which contains boulders of rocks of the same nature as that forming the surrounding country, that the cassiterite occurs in irregular patches.

A small quantity of tin, but of no commercial importance, is met with in the upper stratified sand.

It is a noteworthy circumstance that the ground to the south of Prospectors Creek contains a fair quantity of tin in the surface débris, but, as yet, search has failed to discover the lode from which the tin crystals undoubtedly came.

There are reefs and dykes from which tin has been derived, scattered over a fairly wide extent of country; but upon none of them has any great amount of work been done up to the present. Some of the dykes bear a marked resemblance to those in the Western and Coolgarra districts.

These dykes are intrusive basic igneous rocks. So far as is at present known, these do not attain any very great thickness, nor does their horizontal extension appear in this district to be very great.

Two leases have been taken up—the 40-acre lease, and the 60-acre lease; these are situated about 8 to 9 miles east from Kangaroo Hills Station.

In the 40-acre lease, situated on the eastern bank of the gully, a tributary of the Douglas, a cutting has been put in on the face of the hill upon a tin-bearing lode in granite country, which appears to trend north-east and south-west. A section across this lode shows on the north about 30 inches of gangue made up of quartz and chlorite, with the binoxide of tin disseminated through it. Small quantities of the blue and green carbonates of copper are also contained in the gangue. Adjoining this to the south there is a thickness of about 30 inches of quartz. A thin film of serpentine separates the quartz from the gangue.

A few yards up the hill another cutting has been put in with the object of following a vein running north 65 degrees east. The matrix of the vein is similar to that above described.

Near the head of the gully an open work shows a wedge-shaped mass of quartz and chlorite trending due east. Both walls are granite, the faces of which are often coated with the green carbonate of copper. Some very large crystals of cassiterite could be seen in the quartz lying near the surface.

Still further up the creek a shallow shaft has been sunk upon a vein which has a course of north 30 degrees east. The vein has a thickness of from 1 to 12 inches. Hæmatite, limonite, and iron pyrites occur associated with the quartz and tin.

The Sixty-acre Lease lies some distance west of the last. Upon it a shaft has been sunk to a depth unknown to my informant.

In the shaft a leader with a general course of north-east and south-west is met with.

Where the shaft now stands a good bunch of tin-bearing gangue about 2 ft. 6 in. across has been met with. The gangue is quartzose chlorite of a nature similar to that met with throughout the district.

West of the shaft an open work shows a good leader of variable thickness underlying to the north and trending east and west. The open work, 20 feet in depth and now full of water, is reputed to have yielded a fair quantity of tin ore.

The only returns of the output of the tin ore from this field are scattered through the annual reports of the Mines Department and the records kept in the Custom House, Dungeness.

The

The following is a Tabulated Statement of the Yield of Tin from the Kangaroo Hills District, so far as can be obtained. This table includes the yield from the recently discovered alluvial field in Dingo Creek, distant about 30 miles from Kangaroo Hills:—

Year.	Yield of Black Tin,	Authority.
	Tons. cwt. qrs.	
1885	100 0 0	Mineral Wealth of Queensland.
1886	121 0 0	Annual Report, Mines Department 1886.
1887	83 6 0	Customs Records, Dungeness.
1888	117 16 0	„ „
1889	137 0 0	„ „
1890	38 0 0	„ „

Bismuth.—Fragments of carbonate of bismuth have been discovered in the alluvial gravels in the neighbourhood of Kangaroo Hills. Recently bismuth has been met with in one of the creeks draining into Halifax Bay.

Iron.—Ores of iron are very plentiful throughout the district.

In one of the branches of Biscuit Creek, about nine miles down the river below Kangaroo Hills Station, there is a large lode of hæmatite in quartz country. The ore has a considerable disturbing effect on the magnetic needle.

Some distance north of Donnybrook there occurs what is known as the Iron Mountain; this rises to an altitude by aneroid of 200 feet above the level of the camp at Donnybrook.

The Iron Mountain in reality occupies one end of the cap of a lode which can be traced for some distance.

In places there is a kind of quartzose gangue. At one spot huge blocks of hæmatite and limonite stand out in bold relief upon the back of the lode.

The general course of this lode is north-west and south-east. Numerous veinlets branch off at right angles to the strike. At one place merely small bunches and veinlets of hæmatite occur in the gangue, in addition to small quantities of the blue and green carbonates of copper.

Near the "mountain" the lode or mass presents a steep escarpment to the east.

On the face green and blue carbonates of copper form botryoidal and stalactatic masses in a cavern about 9 feet in height, which runs for a few feet westwards.

Along the whole course of the lode a little surface work had been done, and this served to show that the general character of the ore is the same throughout its whole length.

The linear persistence of this lode is most marked.

A. GIBB MAITLAND,
Assistant Geologist.

Price 1*s.*]

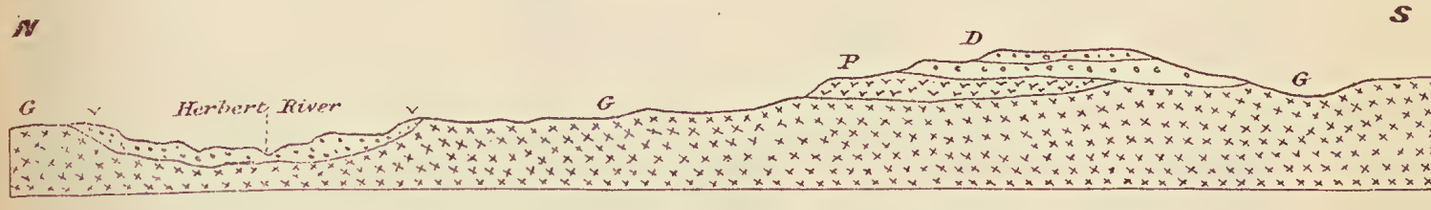
By Authority: James C. Beal, Government Printer, William street, Brisbane.

Section I

Section near the Valley of Lagoons Station.

B' = Vesicular scoriaceous Basalt.
B = Compact Basalt.
D = Ferruginous conglomerate, 3 feet in thickness.
S = Micaceous and quartzose Schists.

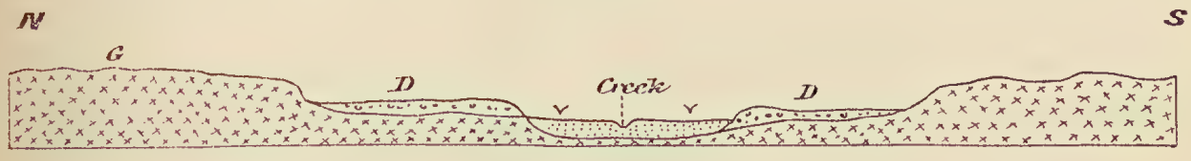
Section II



Section from the Herbert to the Burdekin Divide

ˇ = Alluvial Deposits.
G = Granite.
P = Acidic Lavas.
D = Ferruginous Sandstone.

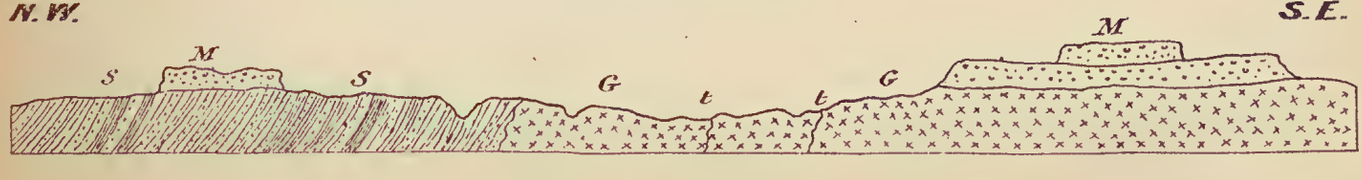
Section III



Section across Blackfellows Creek (Burdekin Tributary.)

ˇ = Alluvial Deposits.
G = Granite.
D = Ferruginous Sandstone.

Section IV



Section near Kangaroo Hills Station

M = Coarse Grits and Conglomerates. (Star Beds)
S = Highly inclined Shales &c. (Burdekin Beds).
G = Granite;
tt = Tin bearing Lodes.

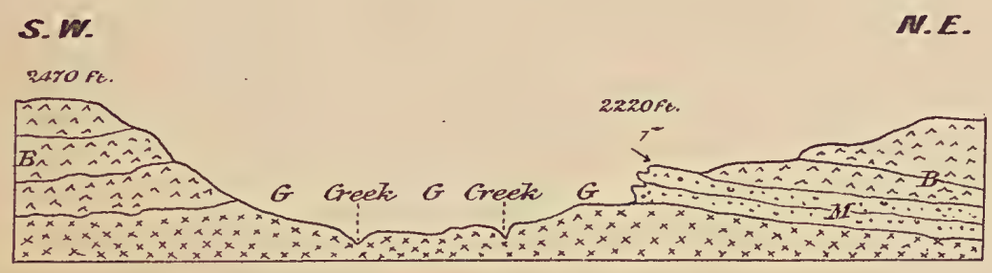
NATIONAL MUSEUM

Section II

Generalised Section across "The Blue Range."

R = Shales, Greywackes and Quartzites (Burdekin Beds) *M = Coarse white Grits and Conglomerates. (Star Beds).*
F = Fault.

Section I



Section near Mount Fox.

B = Compact basaltic Lavas. *M = Quartzose Grit.*
G = Coarse micaceous Granite

Section III

Section east of the Valley of Lagoons Station.

v = Recent superficial deposits. *D = Desert Sandstone.*
R = Buff Sandstone. *S = Contorted Schists.*

Gov. Litho. Office
Brisbane.

With the compliments of
Robert L. Jack,
Government Geologist.
GEOLOGICAL SURVEY OFFICE,
TOWNSVILLE, QUEENSLAND.

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891.

NSLAND.

COOLGARRA TIN MINES AND SURROUNDING DISTRICT.

(REPORT BY A. GIBB MAITLAND, ASSISTANT GEOLOGIST, ON THE)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

The following Report is intended to describe the geological features of the Coolgarra District, and such of the mines as were open to inspection at the time of my visit (July 1890), and is accompanied by a map, compiled from surveys by Mr. P. Grant, Mining Surveyor, Herberton, on a scale of 10 chains per inch, showing the general features of the country in the more immediate vicinity of the Township of Coolgarra.

GEOLOGICAL FEATURES OF THE DISTRICT.

The tin mines are situated near the head of Return Creek, a tributary of the Herbert River.

Approaching the township of Coolgarra from the divide between the Herbert and the Burdekin, the country consists of very rough basalt interspersed with a few waterless comparatively open plains.

After travelling some miles over these plains granite emerges from beneath the basalt, and continues to occupy the country in the vicinity of the road until nearing Cunnawarra Station, when its place is taken by schistose rocks. In the neighbourhood of the head station the prevailing rocks are vertical schists overlain in places by sheets of basalt, which appear to occupy portions of some of the existing valleys.

Between Cunnawarra Station and the Hot Springs, near Woodleigh, the road passes over rather flat sandy country, with scarcely a section visible. Probably the underlying rock is granite.

Within four miles of the Hot Springs, portions of the country are occupied by basalt. In the vicinity of the Hot Springs the prevailing country rock is a granite of variable composition and texture, intersected by dykes of felsite, and a rock not unlike a quartzite in appearance.

The springs are situated in the bed of Innot's or Nettle's Creek, a tributary of the Herbert River, and about 2¾ miles north-west of Woodleigh Station, at an altitude by aneroid of 120 feet above Cunnawarra, or about 1,900 feet above sea-level.

Tradition has it that some years ago the present site of the springs was occupied by a large water-hole full of and overflowing with hot water. This was a favourite camping ground for travellers, who were attracted by the valuable medicinal properties which these waters were said to possess.

An hotel and bath-houses have been built, and another hotel is in course of erection. The locality bids fair to become a favourite resort.

The temperature of the water as it issues from the spring is said to be 180 degrees Fahrenheit. Not having a thermometer with me I was unable to verify this statement.

The only analysis of the water which is believed to have been made is that by the late Mr. Karl Staiger, sometime Government Analyst, who "reported that the sample analyzed by him contained 61·126 grains of solid matter in one gallon, viz.:—

"Chloride of Sodium	25·245
Alumina and Iron	2·057
Carbonate of Lime	2·304
Sulphate of Lime	5·230
Silica	6·110
Insoluble Solids	16·040
Organic Matter	4·140
Lithia	trace

"This analysis, however, must not be considered as conclusive as it was made of a small quantity, quite insufficient for the purpose: it will be seen that Mr. Staiger does not even mention the carbonates of soda and magnesia which the water is known to contain—in fact, in one hundred parts of solids the carbonate of soda constitutes 12·8."*

There appear to be at present two main outlets for the water at x and y (figure 1, plate 1), while in two small holes hot water is met with, but overflows very feebly.

The outlet x in the sandy bed of the creek, about 9 feet from the eastern bank, is connected by piping with y, which is about 20 feet further east. The outlet x has an elevation from 1 foot to 18 inches above the bed of the creek.

A fairly large quantity of gas, which has a slightly sulphurous odour, is constantly being given off.

Where the water emerges through the sand, which fills the bed of the creek, a square tub has been inserted in the sand to collect it. The water overflows, and a good deal of it runs away down the creek. A fairly large quantity of gas which has a slight sulphurous odour is constantly being given off with the water.

For

* "The Mineral Springs of Australia," by Ludwig Bruck.—*Australian Medical Gazette*, January, 1891.

For some distance round the orifice *x*, the sand still retains a considerable portion of the heat derived from the percolation of the heated water through it. In some places it is nearly impossible to place one's hand in a hole dug in the sand to a depth of about eight inches. A considerable portion of the water from the main orifice still finds its way down the creek by percolation through the sand, without even rising to the surface.

No deposit exists around the mouth, but many of the pebbles in the more immediate vicinity of the overflow are covered with an exceedingly thin white coating.

The outlet *y* (figure 1, plate 1) is on the bank of the creek, and a fair quantity of water rises and is allowed to overflow into *x*, but no gas appears to be emitted from this outlet.

The pool *z* is distant about 20 feet south of *y*. It is about 3 feet by 2 feet across, and about 10 to 12 inches deep. The temperature of the water is much below that of the other two sources, and the quantity of overflowing water is not nearly so great. The bottom of the pool is covered with a fine mud. Bubbles of gas rise almost continuously through the water.

About 30 feet further south, on the bank of the creek, another similar pool to the last occurs. The water has a temperature slightly exceeding that of the surrounding air. Very little water overflows, and no gas is emitted.

From the Hot Springs to Coolgarra the road passes over granite country.

The township of Coolgarra, situated near one of the heads of Return Creek, is by aneroid 550 feet above the springs.

The country in the immediate vicinity of the township consists of a series of altered vertical greywackes, quartzites, and shales, bounded on the east by lofty granite ranges. In portions of the district, notably where they approach the granite, the sedimentary beds have a very flinty and felsitic look.

The major portion of the waters of Return Creek flow over alternations of these sedimentary strata.

The boundary between the granite and the sedimentary rocks is not well defined.

About six miles down the creek the altered sedimentary rocks are replaced by acidic lavas and ashes, similar to those of Croydon, the Newcastle Range, and Cleveland Bay. What relation these bear to the greywackes and shales could not be made out. The lavas appear *primâ facie* to rest unconformably upon the altered sedimentary rocks.

Resting directly upon the lavas, about six or seven miles down the creek below Coolgarra, denuded relics of a once extensive belt of white saccharine limestone are encountered.

A very noticeable feature in the district is the occurrence of dykes of some altered basic rock. These dykes are the main sources of the tin ore. They appear to be more prevalent among the sedimentary strata than amongst the granitic rocks. As noticed by Mr. R. L. Jack during the examination of the tin mines of the Western District, there exists an "intimate connection" of the tin deposits with these "metamorphosed igneous dykes." These tin-bearing dykes have no prevailing direction. Sometimes they intrude themselves along the planes of bedding of the sedimentary rocks, and at other times they follow joint planes. Cases were noticed in which it appeared as though they have even penetrated quartz reefs.

The percentage of tin in these dykes varies very much in different portions.

Throughout the "stone" the mineral cassiterite occurs in an exceedingly irregular manner. There are no lodes in the proper sense of the word. The tin ore occurs sometimes in fine "strings" or "leaders," often swelling out into large bunches. At other times a certain amount of the ore is disseminated through the body of the dykes.

Cassiterite, the binoxide, is the only ore of tin found in the district. It occurs sometimes in crystals of all colours, and sometimes massive. Specimens of wood tin, said to have been obtained from one of the gullies in the neighbourhood, were shown to me.

In addition to "lode tin," a certain amount of stream tin has been obtained by washing the gullies.

The minerals with which the tin is associated are—Aluminite, azurite, chlorite, fluorspar, goethite, hæmatite, limonite, malachite, mispickel, penninite (? hydrous talc), pyrites, quartz, topaz, and wolfram.

Appendix A is a return extracted from the records in the office of the Mineral Lands Commissioner, Herberton, showing the quantity of tin ore raised and dressed, with the yield of black tin at the Victoria Mills, Coolgarra, from the years 1884 to 1888.

It is a source of regret that at the time I visited Coolgarra most of the mines had been abandoned. The shafts and workings were full of water or otherwise almost inaccessible. For this reason a very minute description of the mines cannot be given. Enough was however seen to enable the general mode of occurrence and associations of the tin to be ascertained.

The result of such examination shows that the method of prospecting cannot be carried out afte the usual fashion in quartz reefs.

The tin is to be looked for throughout the whole body of the dykes. Hitherto the result of following individual leaders has been attended with only, as it were, momentary success. It is quite natural, of course, for some of the tin ore to be concentrated in leaders and veinlets; some even is met with in the adjacent country-rock.

MINES IN THE CENTRAL DISTRICT.

Magdala.

The Magdala is situated on the western face of Magdala Hill.

At a height of 60 feet on the south side of a minor tributary of Return Creek a tunnel has been driven for a distance of 110 feet in a direction south 10 degrees east, along a dyke formed of ironstained quartzose chlorite, which contains many nodules of aluminite. There are many cavities containing quartz throughout the dyke. The binoxide of tin, cassiterite, can be seen with the unaided eye disseminated through the rock. In blocks lying around the mouth it was of a greyish colour. Specimens are said to have been obtained from the surface showing very large elongated crystals of quartz, with cassiterite set in a matrix of botryoidal hæmatite and limonite.

About 20 feet higher up the face of the hill a vertical shaft has been put down to a depth of between 50 and 60 feet, hoping to meet the dyke ("lode"), but without success. A small cutting to the north of the shaft shows a quartzose chlorite dyke about 5 feet thick with a "horse" of country-rock.

The

The main shaft is situated at an altitude of about 160 feet above the bed of the creek at the township. For 50 feet the shaft is vertical, thence it underlies northwards.

A leader of tin which had an underlie of from 35 to 45 degrees to the west-north-west was followed to a depth of 110 feet from the surface. The leader splits up into two parts, one of which has a much steeper hade than the other. From the foot of the shaft a drive has been put in generally north-west to meet the underlie. The lowest workings are, by aneroid, 10 feet above the bed of Return Creek. No work has been done west-north-west of the mouth of the main shaft.

The dyke, the matrix of the tin ore, appears to be an altered basic igneous rock. It contains aluminite with fine tin disseminated throughout, and also a considerable quantity of goethite (?).

A smaller shaft has been sunk some distance north-east from the main workings, but beyond the fact that it showed the presence of a minor dyke nothing was seen.

Six hundred tons of stone crushed from the Magdala have yielded 130 tons of black tin.

Beaconsfield.

The Beaconsfield is situated to the north of the Magdala.

A shaft has been sunk to a depth of 75 feet, and the width of the dyke from which tin has been obtained is 6 feet. An altered basic dyke exists to the south-east of the main dyke.

Fifteen tons of black tin have been obtained by crushing 200 tons of stone from the Beaconsfield.

On the north side of the gully, the tributaries of which drain the lease, occurs a lode from which large blocks of wolfram have been obtained in a matrix of quartz.

The lode trends north-east and south-west.

Bonnie Dundee.

The Bonnie Dundee lies east-north-east of the Beaconsfield.

A cutting has been driven into the hill in an east-south-easterly direction in a basic dyke about 6 feet in thickness, from which a large body of tin has been obtained. A shaft has been put down in the bottom of the cutting to a depth of 75 feet, with the object of following the shoot of tin, but has apparently failed.

A crushing of 600 tons, part at the Coolgarra Mill and part at Irvinebank, yielded 40 tons of black tin.

Fragments of large tin crystals were found to cover the ground and the vicinity of the workings, and were probably derived from the denudation of a dyke. Stream tin has been obtained from the creeks which drain the hill upon which the lease is situated.

North Britain.

The North Britain is situated southwards from the Bonnie Dundee, on the head waters of Derwent Creek. It is now abandoned and little could be seen. A shaft has been sunk to a depth of 35 feet, upon a lode 8 feet in thickness. The tin-bearing stone contains a large quantity of arsenical pyrites.

Thirty tons of black tin are reported as the yield of 180 tons of stone crushed at the Coolgarra Mill.

John Bull.

The John Bull adjoins the North Britain to the south. Four shafts have been sunk to depths—unknown to my informant—upon a line of lode which runs north and south. An open work shows a quartz reef trending north and south, and dipping at an angle of 55 degrees to the west. The total quantity of stone crushed at the Coolgarra Mill, 450 tons, yielded of black tin 52 tons.

Victoria.

The Victoria adjoins the John Bull on the south.

A shaft has been sunk to a depth of 117 feet, but being full of water as far as the timbering nothing was to be gained by descending. The reef was apparently running east and west. At the foot of the shaft the thickness of the reefs is said to be 12 feet. From specimens lying at the surface the ore appears to be galena, iron pyrites, and tin, in a quartzose matrix. The total quantity of black tin, as the yield of 450 tons of stone crushed, is reported to have been 140 tons.

A claim known as the Young Almanack lies west from the Magdala.

A little distance south-east from the boundary a cutting has been opened north and south, and at its southern end tin-stuff (basic dyke), said to average from 5 to 6 per cent of tin, has been obtained.

To the west of the south-west corner of the Magdala a tunnel has been driven north-east into the face of the hill for a distance of 275 feet; it then turns east for 25 feet. At about 220 feet from the mouth a vertical dyke of ironstained chloritic-matter is pierced. The dyke runs west-north-west, and is 12 inches thick; it contains a little tin.

At the end of the tunnel a large dyke of similar material has been penetrated. It runs north and south, and its boundaries are well defined. A winze at the end of the tunnel has been put down 20 feet, with a slight underlie to the north, with the object of following an irregular leader of tin. This dyke can be traced on the surface to the Magdala shaft. Kernels of aluminite with a little green carbonate of copper containing finely disseminated tin occurs in the rock. Throughout the body of the dyke diligent search seldom fails to reveal the presence of tin ore. Three hundred tons "tin-stuff" from this locality crushed at the Coolgarra mill are said to have yielded 34 tons of black tin.

Stephen's Extended.

These workings are situated some considerable distance south-west of the township.

The best quality of smelted tin is reputed to have been obtained from this ground, which is said to have yielded about 70 to 80 tons. The matrix of the ore appears to be an altered dyke of a nature similar to that met with in other portions of the field. Two shafts have been sunk. The total depth of the workings is now about 150 feet. Down the westernmost shaft, at a depth of 20 feet, a drive has been put in east and west. To the west a good leader of tin in a clayey (?) gangue has been followed south-east for a distance of 40 feet. A few leaders of well nigh pure tin ore were met with in various parts of the workings, and are to be followed at some future time.

At

At a depth of 140 feet, about 5 feet of red chloritic-matter containing unevenly distributed tin ore have been met with.

A crushing of 1,900 tons of tin-stuff has yielded 185 tons of black tin.

Saint Patrick.

The Saint Patrick is situated on the slope of a hill west from the township. Work has been done upon a "reef" 6 feet in thickness underlying to the east, and striking generally north and south.

A shaft has been sunk to a depth of 70 feet.

Eighteen tons of tin are reported as the result of a crushing of 350 tons.

Grand Junction.

The Grand Junction occupies the highest point upon the north-western end of a hill known as the Grand Junction Hill. A shaft has been sunk to a depth unknown to my informant, upon a leader which apparently trended north-west and south-east. The tin-stuff, judging from surface specimens, is mainly quartz and hæmatite.

From another shaft 4 feet to the north-west in the line of lode, it appears that the reef has a tendency to underlie to the north-east.

Junction Extended.

The Junction Extended is situated on the southern slope of the hill, and is now abandoned and the shaft full of water. The tin-bearing stone runs apparently north and south. Two or three crushings have been sent from this ground to Irvinebank, and the percentage of black tin is said to have been about 40.

Austral.

Upon the Austral ground a tunnel has been driven for some distance south-east to meet a "lode" running east-south-east. A shaft with an underlie to the north-east has been put down to a depth of 20 feet, but is now full of water. A good deal of stone has apparently been obtained here. Sixty tons of stone crushed have yielded from the Coolgarra Mill 8 tons of black tin.

Tasmania.

The Tasmania has a shaft sunk to a depth of about 15 feet, but quite inaccessible at present. On the face of the hill, to the north of the shaft, an openwork shows at its northern extremity a thin vertical leader 10 to 12 inches in thickness. This has apparently thickened out to the south to a width varying from 8 to 10 feet, with a few "horses" of country-rock. The matrix of the lode is mainly quartz containing hydrous talc (penninite) and hæmatite. Tin ore being not very plentiful the claim has been abandoned.

Christmas Eve.

A shaft has been sunk to a depth of 60 feet upon a lode 4 feet in thickness. The shaft was inaccessible at the time of my visit.

Thirty tons of stone taken out and crushed are reputed to have yielded 5 tons of black tin.

Never-Can-Tell.

This claim is situated due north of Mount Bismarck, the highest peak in the vicinity of Coolgarra Three shafts have been sunk at an altitude of 160 feet above the creek.

The workings, long ago abandoned, were, owing to the dangerous nature of the timbering, quite inaccessible.

The most interesting feature in connection with this mine is the occurrence of numerous topazes in a ferruginous matrix. The ferruginous matrix in which the crystals are embedded has been ascertained by Mr. A. W. Clarke, of Charters Towers, to be "decomposing orthoclase and plagioclase." These are said to have occurred in the body of the reef.

Mines in the Outside Districts.

Due west of the township a little work has been done upon a copper lode which is situated on the face of what is known as the Round Mountain.

The lode appears to trend north-west and south-east. Two shallow shafts have been sunk upon it. The matrix of the lode is in places mainly quartz, which sometimes assumes the form of large hexagonal dog-tooth shaped crystals. The matrix contains the green and blue carbonates of copper, together with cuprite, the red oxide, and large crystals, and massive fragments of wolfram. The main body of the ore is cuprite, which contains sparingly large quartz crystals. The red oxide was seen to be often altered into "the" reddish-brown earthy ferruginous variety "generally known as tile ore."

At the surface the width of the lode is from 6 to 8 feet. The ore at the surface appears to have occurred as a large bunch, and, as far as the southern half showed, seems to have died out at a depth. Fig. 2, plate 1, gives a general idea of the section across the reef.

Koh-i-noor.

The Koh-i-noor strikes north 65 degrees west underlying to the north 25 degrees east.

Two shafts have been sunk upon the lode. The depth of one is said to be 60 feet, and shows the width of the lode at the foot 6 feet. The depth of the second shaft was unknown to my informant. Access to these could not be obtained. From specimens lying at grass in the northernmost shaft the matrix of the lode appears to be quartz stained with lead oxide. The quartz contains also nodules of lead sulphate with kernels of unaltered galena in the centre. The green carbonate of copper is not uncommon in some of the specimens. Some of the galena is said to have assayed as much as 500 ounces of silver to the ton.

The outcrop can be traced to the west for some considerable distance; it consists, however, mainly of quartz with very little mineral of any kind.

The country is greywacke or grit. I am informed that 11 tons of stone treated have yielded silver at the rate of 94 ounces per ton, and of lead 40 per cent.

The same line of lode is apparently continuous to the eastward for about a mile, and has numerous branches joining it. A little

A little work has been done at the eastern end, and galena said to assay as much as 200 ounces of silver to the ton has been obtained.

Near the eastern extremity an open work shows a quartz reef underlying at 50 degrees to 60 degrees to north 75 degrees east, and trending north 25 degrees west. Tin has been obtained, and is seen to occur in a kind of leader in the reef. This is said to have yielded tin-bearing stone, averaging as much as from 4 to 5 per cent. The tin stone is a dyke of chloritic matter. A little tin is also met with in the quartz.

Tucker's Silver Lead Lode.

This lode, now abandoned, is situated on the eastern bank of Return Creek.

The strike of the lode is north-west and south-east. Along its outcrop there are several disused and inaccessible shafts. The matrix of the lode is quartz stained with lead oxide, and containing both the sulphate and the sulphide of lead. "Tin-stuff" was also seen in some of the specimens which had been raised.

William (Anderson's Tin Lode).

This, situated in greywacke country, runs north and south. Several open works exist along the line of lode. The main shaft was full of water, and nothing could be seen.

The matrix is a basic dyke of the usual nature. An exceedingly well defined footwall—if such a term can be used in connection with a deposit of this class—is a plane of bedding.

Mount Garnet.

Some work has been done upon a line of lode near Mount Garnet, situated on the western bank of Return Creek, near Mullaburra.

A little distance south from the mountain itself a shallow shaft has been sunk upon what appears to be little else than a portion of some of the acidic lavas (with which this portion of the Coolgarra district is mainly made up), coated along joints and crevices with botryoidal green carbonate of copper.

A shaft has been sunk, and said to be 50 to 60 feet in depth, but at the time of my visit was inaccessible. In one place I was informed that the "lode-stuff" was over 15 feet in width.

From specimens collected by myself from the cap of the lode, it appears that the ore is an argentiferous admixture of galena, minetite (arseno-phosphate of lead), blue and green carbonates of copper, fahlerz (sulphide of copper and antimony), hæmatite, limonite, and a fair percentage of siliceous matter.

APPENDIX A.

Return extracted from the records in the Office of the Mineral Lands Commissioner, Herberton, showing the Quantity of Tin Ore raised and dressed, with the yield of "Black Tin," at the Victoria Mill, Coolgarra, from the year 1884 to 1888:—

—	Stone Crushed.	Yield of Black Tin.
	Tons cwts. qrs.	Tons cwts. qrs. lbs.
Year ending 31st December, 1884	1,005 15 0	70 6 1 20
„ „ 1885	750 0 0	45 0 0 0
„ „ 1886	2,211 11 0	172 8 0 4
„ „ 1887	654 4 0	41 13 3 8
„ „ 1888	230 0 0	13 4 0 0
	4,851 10 0	342 12 1 4

A. GIBB MAITLAND,
Assistant Geologist.

Price 5d.]

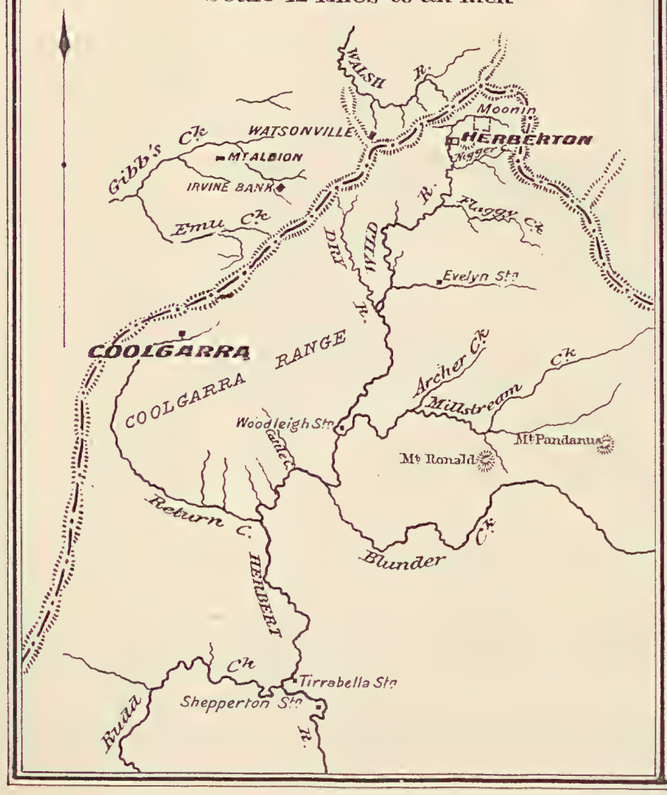
By Authority: James C. Beal, Government Printer, William street, Brisbane.

Geological Map of the COOLGARRA Tin Mining District
1890

S
S
G
G
S

Township of Coolgarra
ELMA ST.
ELSIE ST.
MARY ST.
LUCY ST.
STUART ST.
Track to Thompson's Creek
Water Reserve
WOLFRAM LODE
Shaft
BEACONSFIELD
Shaft & Open cast
BONNIE DUNDEE
Shaft & Open cast
NORTH BRITAIN
Magdala Hill
Line of Shafts
JOHN BULL
Tunnel
MAGDALA
Shaft
Shaft
Tunnel
Shaft
VICTORIA
CALEDONIA
Derwent Waters
Return Ck

LOCAL SKETCH MAP
Scale 12 Miles to an Inch



INDEX OF COLOURS & SIGNS

Greywackes &c. S — Granite & Felsite G — Basic Dykes B

Metalliferous Reefs 25° the Triangle shews the direction of the underlie, and the figure the amount.

Scale 10 Chains to an Inch

10 5 0 10 20 30 40

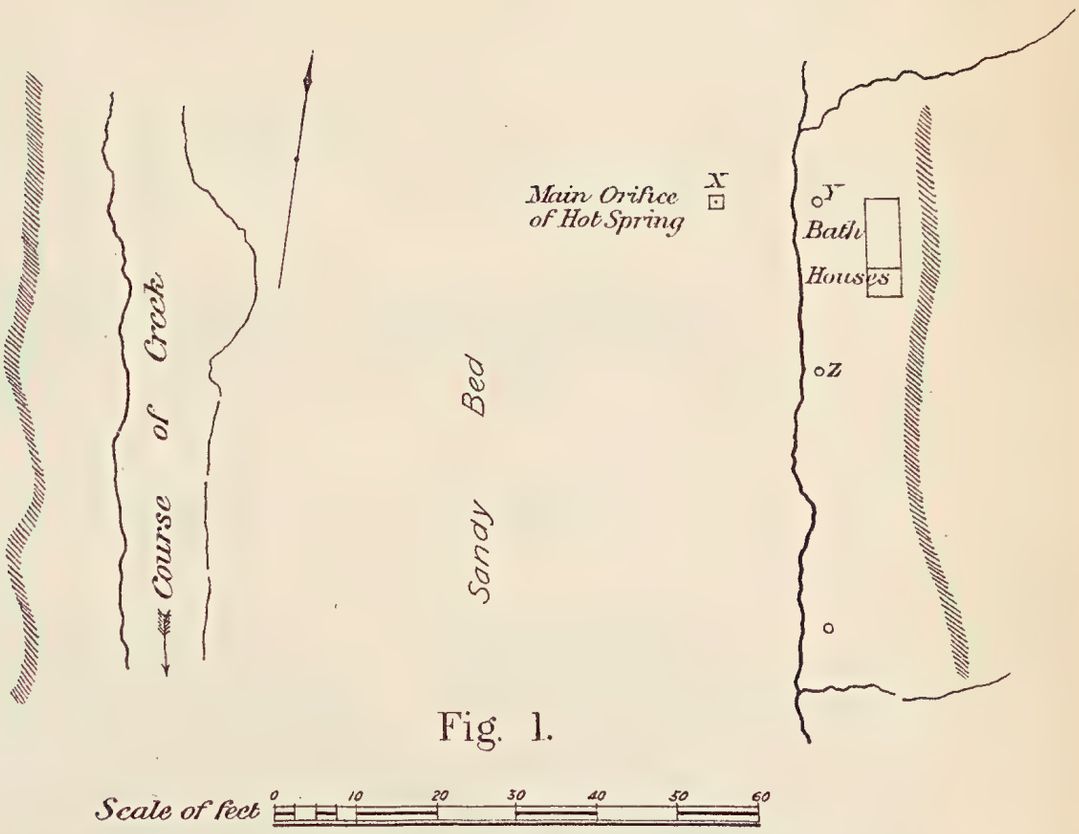


Fig. 1.

Rough Sketch Plan of The Hot Springs near Woodleigh.

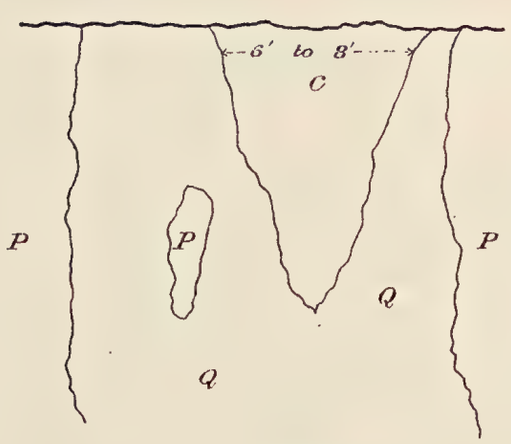


Fig. 2.

Section of the Copper lode at the Round Mountain.

C:- Red Oxide of Copper. Q:- Quartz containing Copper &c. P:- Porphyry.

With the compliments of
Robert L. Jack,
Government Geologist.
GEOLOGICAL SURVEY OFFICE,
TOWNSVILLE, QUEENSLAND.

13

1891.

QUEENSLAND.

CAPE RIVER GOLD FIELD.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON THE)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Leaving Maryborough about the middle of February, it was not until April that I was able to start field work at the Cape River, on account of the exceptionally wet season, and then even I experienced the greatest difficulty in travelling, owing to the boggy nature of the country.

Starting work near the railway line at the Cape River, I followed that river up to its heads, examining the country in detail at the various places where alluvial or reef gold had been discovered. I then crossed over the range at the head of the Cape River, on to the Flinders waters, and camped in the neighbourhood of Oxley Creek, where a considerable amount of prospecting for gold has been carried on. After examining the "Desert Sandstone," and basaltic plateaux of the Flinders, I crossed over to Lolworth to see the "great basaltic wall" lying between that station and Toomba, about forty-five miles to the east.

Proceeding in a southerly direction, I next visited the Old Homestead Diggings, and then the New Homestead Diggings, on the southern side of Great Northern Railway Line, and about six miles east of the Homestead Railway Station. The country between the Cape River and Charters Towers could not be examined in any detail on account of the boggy nature of the country.

From Charters Towers I went to Mount Leyshon, with a view of reporting as to the probability of obtaining artesian water in the district. I next travelled *viâ* the Bluff and the Livingstone Reefs to the Dreghorn Diggings, and then on to Harvest Home and Mount McConnell Stations, where "Star Beds" occur, returning to Charters Towers, *viâ* Ravenswood and Cardigan Stations, and the Broughton.

Rocks belonging to the following formations, named in chronological order, are described in this Report:—

Recent River Alluvium.
An Older Alluvium.
Basalt (of Tertiary age).
Desert Sandstone (Upper Cretaceous).
Star Beds (Lower Carboniferous).
Granite (age undetermined).
Schists (age undetermined).

The Cape River Gold Field is one of the oldest—if not the oldest—goldfields in the northern portion of the colony. It was yielding large quantities of alluvial gold some years before Charters Towers was discovered.

The late Sir R. Daintree, then Mr. Richard Daintree, published in the year 1868 a geological report upon the Cape River Gold Field, to which I shall have to refer in this Report.*

THE METAMORPHIC SCHISTS.

The Cape River Gold Field comprises a series of schists and quartzites of vast thickness, extending for a distance of over fifty miles in length, with an average of about ten miles in width. The schists "strike" about W.N.W. and E.S.E., and have an average dip of from 30 to 35 degrees to the S.S.W. As there is no sign of folding or repetition of the rocks, the same dip continuing throughout, this would give a thickness of between five and a-half to six miles of these rocks; nor is this even their entire original thickness, for to the N.N.E. their place has been taken by intrusive granite, leaving only here and there traces of the original schists.

The schists in reality extend to a much greater distance in the direction of their "strike," but they are covered with basalt. For instance, just north of Lolworth there are two small hills, "inliers" of schist, and the same rock crops out at Cargoon Station. The schists of the Woolgar Gold Field are probably a continuation of the same series, separated by a large layer of basalt, and they are probably continuous with the schists of the Gilbert River, separated only by beds of overlying "Desert Sandstone." How far in the opposite direction—to the E.S.E.—they extend it is impossible to say, as the country is all a large alluvial flat. The

* Report on the Cape River Diggings, and the latest Mineral Discoveries in Northern Queensland, by R. Daintree. By authority, 1868.

The lower portion of this series of schists—that which extends along the north-north-eastern part of the field, and includes Mount Davenport and the Upper and Lower Cape—consists of mica and hornblende schists into which granite has intruded to such an extent that the area occupied by the granite is greater than that of the original schists. There is also an interbedded and somewhat laminated granite in this portion of the field, which may be due to extreme alteration of the schists.

Above this is a great thickness of mica schists with thin beds of hornblende schists; these rocks are softer, and have been worn away to a great extent by denudation, leaving large alluvial flats, with here and there small rounded hills of somewhat harder schist, which stand out prominently.

The highest portion of the series—that extending along the south-south-western portion of the field—consists chiefly of quartzite with hardened schists, which, on account of their hardness, have resisted denudation, and have determined the rough and hilly nature of this part of the field. The long spur, running in an east-south-easterly direction from the main dividing range at Mount Miller to Mount Remarkable, a distance of about thirty miles, is composed almost entirely of quartzite.

Mr. Daintree, on lithological grounds, divided these beds into three divisions—the upper, middle, and lower. In the absence, however, of any fossil contents—and they are not likely to be met with in rocks so much metamorphosed—and as the deposition of the strata appears to have been continuous throughout, I do not think there is sufficient reason for keeping up these divisions.

With reference to the age of the schists, I can say nothing more than that they are the oldest rocks of the district, as the granite to the N.N.E. does not form the base or bed on which they were originally deposited, as intimated by Daintree, but has since intruded into the schists. Daintree probably refers to the Devonian beds of the Clarke River when he says, "that rocks of a similar character further north are unconformably overlaid by others containing abundance of upper silurian fossils." The fossils of the Clarke River beds have since been pronounced of Devonian age by Mr. R. Etheridge, senior.

In describing these schists, and the reefs in them, I will take the places in the order in which I visited them.

Mount Davenport, near the foot of which I made my first camp, is situated about one and a-half miles N. 27 degrees E. of Hawthorn Vale Station, on the Cape River. Its summit is 630 feet above the Cape River, and about 1,930 feet above sea level. The hill consists of a white mica schist, in which the scales of mica are exceptionally large. The rock is composed wholly of mica, and small grains of quartz.

The schists on the northern side of the mountain dip S.S.W. at 40 degrees. Several quartz reefs crop out on the slopes of the mountain, most of which are running parallel with the "strike" of the schists. I noticed two cross reefs which had a north and south trend.

Near the foot of the mountain, on the northern side, thin sheets of granite alternate with micaceous schists; these are intrusive and not interbedded, as in places they send out small veinlets into the schists. A short distance further north again the country is almost entirely of intrusive granite, which sends out numerous veinlets into the schists at its junction.

A small boss of granite occurs on the southern slope of the mountain, at the spot coloured as elvan in Daintree's map. (*See* Fig. 1, section across Mount Davenport to the Cape River.)

Nearly all the gullies on both sides of the mountain have been payable, some of them having been washed over again by Chinamen. None of the reefs on the mountain itself have been tried.

Only two reefs—the Union and the General Grant—have been worked in this locality.

The Union Reef.—The Union Reef is situated about three-quarters of a mile west of Mount Davenport, between that hill and Davenport Creek. It bears N. 15 degrees W. and underlies E. 15 degrees N. at about 10 degrees. The reef can be traced along the surface for over a mile in length, and a large number of shafts have been put down to a small depth to test it. The main shaft is on the prospecting claim, and is down to a depth of 180 feet. The shaft is abandoned, and I could not descend it. The reef is a big one, in places over 3 feet to 4 feet in width. The quartz is lying in layers parallel with the run of the reef. The gold was coarse and occurred in patches, some of which were very rich, but away from these patches the reef contains little or no gold. The quartz containing the best gold was hard and veined with red oxide of iron, which gives it a somewhat mottled appearance.

Surface workings around this shaft and in other places along the reef yielded good returns of gold. The country rock is a fine-grained, dark-coloured micaceous schist, with thin beds of hornblende schist. The dip is S. 25 degrees W. at 25 degrees. A battery was once at work on this claim, but that has been sold, and all work has been abandoned for some years.

The General Grant Reef.—This reef lies 480 yards west of the Union Reef. It bears N. 10 degrees W., and underlies E. 10 degrees N. I was informed that as much as 3,000 oz. of alluvial gold was taken from the flat immediately below this shaft. Rich patches of gold occurred in the reef. The shaft, which has been long abandoned, was 110 feet in depth. The country rock consists of fine hornblende and mica schists. The two reefs were of much the same character.

Granite dykes cross the Union Reef in a north-easterly direction. The granite is coarse and contains large flakes of mica. One of these dykes is seen in Davenport Creek, a barren-looking quartz occurs on both sides of it. These dykes appear to have had no effect on the richness of the reef.

Near the base on the eastern side of the mountain a nice-looking quartz reef runs N. 10 degrees E. in hornblende schists.

On Mount Stuart, which is situated about a mile and a-half east of Mount Davenport, several reefs exist which have never been tried.

About four years ago a number of reefs, known as the Pentland reefs, were discovered on the low undulating ridges about four miles S.S.W. of Mount Davenport, near the road to Pentland.

The country between the Cape River and the Pentland reefs consists of an alluvial flat, in which it is generally believed that a "lead" of gold exists, but so far it has not been tried on account, no doubt, of the extent of country it would be necessary to prospect. It is more than probable that the gold in such a large area of alluvial would be too disseminated to pay.

These ridges are composed of a peculiar granitoid schist, consisting of pinkish felspar, quartz, and layers of white mica. The rock would be an ordinary granite but for the layers of mica, which give it a schistose

schistose character. It is so much decomposed that I could not procure a solid hand specimen. In parts of the rock the layers of mica are very few and far apart, but often they are so numerous that the rock appears to be made up entirely up of mica.

Small dykes of felsite intersect the schists, and I was informed by the miners that they have a decidedly favourable effect on the reefs when in contact with them. The felsite examined in thin sections under the microscope is seen to be made up of a felspathic groundmass, with little or no free quartz.

The following is a description of the reefs:—

The Hayward Reef is situated about 300 yards west of the telegraph line, where it crosses the Pentland road. It bears N. 40 degrees E. and underlies E. 40 degrees S., at angles varying from 20 to 45 degrees. The reef is from 1 foot to 3 feet in width. With the quartz is a quantity of granitic mullock.

The white quartz rarely contains gold. The gold generally occurs in the mullock, and in a quartz streaked with veinlets of oxide of iron. The shaft on the prospecting claim is down 60 feet in depth. The gold occurs in "shoots," which appear to be very narrow. The reef extends for considerably over a mile. The Ellen Francis, which has been worked to the north-east, is probably the same reef.

The country is the granitoid schist. Several small crushings of from 3 to 5 tons of stone yielded from 2 to 3 oz. of gold to the ton. These crushings, however, consisted of thoroughly picked stone, nearly every piece being tried before being included. This was the case with nearly all the crushings from these reefs, because the stone having to be carted to Pentland, and then taken by train to Charters Towers, it would not pay to send stone likely to go under 2 oz. of gold to the ton. The reef was not being worked.

The Sarah Howson Reef is of a similar character to the Hayward, and in the same country rock. It is situated about a quarter of a mile N.W. of the Hayward. It bears N. 30 degrees E. and underlies E. 30 degrees S. The middle of the reef formation is often as much as 4 feet, the gold-bearing portion varying from 6 inches to 2 feet. The reef can be traced along the surface for over two miles. In Freestone's shaft, which is 54 feet in depth, the reef is of a mullocky nature, consisting to a great extent of a decomposed felspathic rock with veinlets of quartz through it. The reef has been "stoped" from the bottom of the shaft to the surface on the "shoot" of gold. The following are some of the crushings:—

6	tons	...	...	...	...	yielded	2	ozs.	10	dwts. of gold per ton.
13	„	...	...	...	...	„	2	„	2	„ „ „
37	„	(from 20 to 45 ft. in depth)				„	1	„	3	„ „ „

Some smaller crushings yielded from 5 to 6 oz. of gold per ton. The value of the gold is £3 8s. 2d. per oz. Another shaft on the same claim is down 70 feet; the quartz at the bottom contains a little iron pyrites. A thin bed of brown hematite crosses the reef near this shaft.

The Big Reef.—This reef is situated about 300 yards N.W. of the Sarah Howson, and is of similar character to the above. It bears N. 30 degrees E. and underlies E. 30 degrees S. very steeply. The reef is 4 feet in width. The last crushing from this reef went 1 oz. 13 dwts. of gold per ton.

The Just-in-time Reef is situated about a mile south of the above. The shafts on this line were all full of water, and nothing could be seen except the surface workings. It bears N.E. and underlies S.E. The reef consists chiefly of quartz, with some reddish granitic mullock. Picked stone crushed 4 oz. of gold to the ton at Charters Towers.

Hughes's Leader lies 300 yards east of the Just-in-time Reef. It bears N.E. and underlies steeply S.E. The width of the reef is from 3 to 5 inches. The country rock is a highly micaceous schist, dipping S.S.W. at 30 degrees. One of the shafts was being worked at the time of my visit. About 60 tons of stone have been crushed from the P.C., and have yielded on an average over 2 oz. of gold to the ton. The quartz contains a little pyrites in it.

The Mystery Reef.—This reef is situated N.E. of the Just-in-time. It is a small reef of from 5 to 8 inches in width. It bears N. 30 degrees E. and underlies E. 30 degrees S. The quartz contains a considerable amount of galena and iron pyrites. The deepest shaft on the reef is 91 feet, but this was abandoned, and partially filled with water. Crushings of picked stone went from 2 to 4 oz. of gold to the ton.

On the north side of the gully, on the same line, there are two leaders of quartz, one on either side of a mullocky lode. This claim was being prospected; the men at work there say that the gold runs very irregularly, being sometimes in the quartz leaders, and at others in the mullock between.

Several other reefs crop out which have never been tried. These reefs have been worked at a great disadvantage on account of there being no machine at hand. The expense of cartage to Charters Towers has prevented their being more thoroughly tested. I have very little doubt, from trials I made of stone which had been discarded, that there are many tons now at grass which would yield about 1 oz. of gold to the ton. The reefs are of good size, and are composed of a good character of stone. They are well worth another trial, and were a machine to be erected in the neighbourhood, I believe the abandoned claims would be quickly taken up.

From these reefs to Pentland the country is all an alluvial flat.

Reefs have been worked at the "Springs" about two miles W.S.W. of Pentland, on the southern side of the railway line.

The Springs Reef.—This reef is situated about a quarter of a mile south of the 150-mile peg on the railway line. It bears E. 10 degrees N. and underlies S. 10 degrees E. The reef consists of quartz with brown hematite. In the western end of the shaft, near the surface, there are leaders on both hanging and foot walls, with 18 inches of mullock between them; altogether the reef is 2 feet 6 inches wide. There is an iridescent iron stain on the facets of the quartz which was mistaken for copper stains. In the eastern end of the shaft the mullock has cut out, and there is a solid body of quartz of a foot in width, consisting of layers of alternate white and iron-stained quartz. Specks of gold were visible in the quartz. The shaft is 80 feet in depth, and is partially filled with water. The country rock, which is much decomposed, consists of an impure kaolin and decomposed crystals of mica. It is probably one of the felspathic schists which show in the railway cutting at the 150-mile peg.

Near

Near the surface the reef crushed just over 1 oz. of gold to the ton, but lower down in the shaft the crushing went only 10 and 12 dwts. to the ton. The workings are abandoned.

Three small quartz reefs have been tried at a place 200 yards east of Calland's house, on the north side of the railway line. They bear N.N.E. The reefs are small, not over a foot in the widest part. Gold is visible in the quartz. The rock is similar to that at the Pentland reefs.

Golden Hill (Calland's Claim).—This reef is situated on the same side of the line, and about three-quarters of a mile W.S.W. of Calland's house; it is 500 yards N.W. of the 150½-mile peg on the railway. The main shaft, 42 feet in depth, was full of water. Calland was working in another shaft close by 16 feet in depth. In this shaft, which is 9 feet by 5 feet, there are leaders of quartz and veins of a soft felspathic rock in a hard quartzite. The leaders are 3 to 4 inches in width. They run at angles varying from S.S.W. to W.S.W. into a reef the width of which has not been determined, and which is running E.N.E. and W.S.W. Gold is showing in all these leaders, the quartz of a cellular character being especially rich. The hard quartz contains small grains of pyrites. I tried five prospects from the leaders, and in three of them I obtained fair prospects of gold, the other two were poor. The country rock is a granitoid schist.

The following are the crushings of stone at Charters Towers:—

			Oz.	dwt.	grs.		Oz.	dwt.	grs.	
11 tons 10 cwt.	yielded		5	6	12	equal to	0	9	7	of gold per ton.
7 „	„		6	3	0	„	0	18	0	„ „
7 „	„		11	6	0	„	1	13	0	„ „

Between Golden Hill and my camp No. 2 at the junction of Running Creek and Specimen Creek, the country is nearly all covered with alluvial flats. A dyke of granite crosses the road about 2 miles below the crossing of Betts Creek.

A mass of felsite occurs on Bett's Creek close to the camp. One specimen, No. 24, of this felsite was a hard white kaolinized and banded rock. A thin section under the microscope shows it to consist of a groundmass of amorphous felspar, with very minute blebs of quartz and specks of magnetite. The banded appearance of the rock is caused by these small blebs of quartz, which are arranged in bands or layers. Another specimen, No. 25, is a hard, compact, reddish-grey rock. A thin section under the microscope shows the rock to have a beautiful perlitic structure. There are in it enclosed specks of a foreign rock, which appears violet under reflected light and nearly opaque under transmitted light. It consists of a felspathic groundmass with minute needle-shaped felspar crystals. Crystals of oligoclase and orthoclase felspar occur throughout it. Magnetite and ferrite also occur freely.

Mount Remarkable District.—Mount Remarkable lies about 6 miles slightly north of west of Pentland. The summit of Mount Remarkable is 2,100 feet above the sea level, and 780 feet above Pentland.

The country in this district consists of fine laminated mica schists, and some granitoid schists of the same character as those of the Pentland reefs. With the above are the beds of quartzite alluded to above, which has resisted denudation to a much greater extent than the surrounding rocks, forming steep and rugged ridges which run for miles in a west-north-west and east-south-easterly direction. This quartzite, when viewed in thin sections under the microscope, is seen to consist almost entirely of rounded irregular-shaped grains of quartz, full of small enclosures.

Another series of ridges run in a more or less north-north-westerly direction. The cap of these ridges is generally composed of a quartz felsite which runs in dykes in that direction. The felsite consists of blebs of quartz, and a few rare crystals of felspar in a felspathic groundmass. These ridges extend for a short distance only. Mount Remarkable itself is made up almost entirely of granitoid schist. Ridgy country extends for over a mile in a north-easterly direction, and beyond that the country is flat as far as the One Tree Hill and Commissioner's Hill, near the Cape River. These hills are composed of schist, and stand out prominently by themselves.

Most of the work in this district has been on the alluvium of the creeks and gullies. Specimen Creek with the gullies running into it, Escort or Store Creek, Quartzite Gully, Nuggetty Gully, Long Gully, Green's Gully, Moran's Gully, Paddy's Gully, Sharpers' Gully, and Golden Gully have all been worked over more than once, and have yielded a large quantity of gold. Chinamen are still working at them, but they are getting very poor returns now. With the exception of two or three Europeans, the whole of the population in this neighbourhood consists of Chinamen.

Specimen Creek, which runs at the foot and on the south side of Mount Remarkable, was very rich in alluvial gold for about a mile and a-half in length.

Several quartz reefs, bearing more or less north and south, occur in the vicinity of Specimen Creek. They have been worked to a small depth, giving fairly good returns, and then have been abandoned on becoming poorer. The gold runs in "shoots," which dip to the S.S.W. Two cross reefs of an opaque, white, barren-looking quartz, run across these reefs in a W.N.W. direction—parallel with the strike of the strata. It is where these cross reefs cross the north and south reefs that the latter contained the richest gold.

Small crushings at Charters Towers, of from 5 to 10 tons in weight of carefully picked stone, have yielded from 2 to 5 and 7 oz. of gold per ton, and in isolated instances as much as from 10 to 20 oz. of gold per ton.

Here again a battery is indispensable to thoroughly test the reefs.

In the following description of the reefs I am indebted to Mr. Norris, an old miner on this field, for much information, such as the depth of the workings, width of reefs, &c., in cases where I could not examine the reef personally.

The Morning Star Reef.—This reef crosses Specimen Creek at a point S. 15 degrees E. of the summit of Mount Remarkable. It bears N. 10 degrees E. and underlies E. 10 degrees S. at 20 degrees. The reef has been worked on the north side of the creek by Norris. It consists of a hard translucent quartz, cellular in parts, and of from 1 foot to 15 inches in width. The country rock is a mica

mica schist dipping steeply S.S.W. The small crushings have averaged from 16 to 17 dwts. of gold per ton, the last crushing of 9 tons going 17 dwts. per ton. The value of the gold was £3 12s. 3d. per oz. The shafts are only a few feet in depth.

In a gully 200 yards S.W. of this there is a quartz reef running parallel with the "strike" of the strata, carrying a large quantity of galena, but no gold.

The Governor Blackall Reef is 300 yards west of the Morning Star Reef. It has been worked at a spot about a quarter of a mile south of the creek. The reef bears N. 20 degrees E. and is nearly perpendicular. It averages about 1 foot in width and consists of a cellular quartz with a greenish tinge from the decomposition of pyrites. The reef has been worked to a depth of 15 feet only for a distance of 80 yards. It can be traced along the surface from Mount Remarkable to Golden Mountain, a distance of over a mile. The country rock is a mica schist, with thin beds of quartzite, dipping S. 30 degrees W. at 40 degrees. The only crushings I could get particulars of were one going 1 oz. 17 dwts. of gold per ton, and one last year which went 1 oz. 10 dwts. per ton. The gold is very fine.

The Victoria Reef.—The main shaft on this reef is a quarter of a mile south of Specimen Creek, and is S. 11 degrees W. of Mount Remarkable. The reef runs N. 10 degrees W. and is perpendicular. The reef is about a foot in width, and consists of a hard white quartz, with small specks of pyrites. The shaft is 40 feet in depth. The gold was coarse and very patchy. Country a mica schist. I have no information as to the crushings.

The Bell-Gay Reef is 200 yards west of the Victoria. It bears north and south, and underlies to the east. The quartz is white, and of a glassy nature, and contains iron pyrites and a little galena and copper pyrites. Small bluish veins of protoxide of iron run through it. The gold was very coarse in the white quartz, and finer in the cellular quartz. Depth of shaft, 70 feet. The reef is said to have yielded 2½ oz. of gold per ton at the surface and 3½ oz. at the bottom of the shaft. It has been worked for a length of about 100 yards.

A small battery was erected on this claim. The country rock is a fine laminated micaceous schist. To the north of the shaft the reef crosses a gully running into the creek, in which good alluvial gold was obtained. Near the mouth of this gully a dyke of dolorite, 8 feet in width, runs N.E. and S.W. through soft laminated mica schist, dipping S. 30 degrees W. at 45 degrees.

A little west of this a dyke runs in an E.S.E. and W.N.W. direction. The reef was rich when in contact with this dyke. The rock is a gabbro; under the microscope it shows the minerals diallage, augite, and a felspar probably labradorite. A dyke of graphic granite occurs 200 yards south-west of the main shaft, running W. 10 degrees N., and is 15 feet wide; running alongside it is a coarse granite containing schorl.

The Lone Star Reef is 70 feet west of the Bell-Gay. It bears N.N.E. and underlies E.S.E. The reef is in a granitoid schist. It has been worked to a depth of 70 feet for a short distance along the reef. A branch reef runs between this and Martin's Reef, a little to the west.

A rich patch of £1,100 worth of gold was taken from this reef, where it was in contact with a cross-reef. Crushings of from 5 to 10 tons of stone have yielded from 2 to 20 oz. per ton. Altogether 104 tons have been crushed for 650 oz. of gold.

Martin's Reef.—This reef is a few yards to the west of the Lone Star, bearing N. 10 degrees E., with an eastern underlie. The quartz from the bottom of the shaft contains much arsenical pyrites. The cross-reef, close to which the gold from this reef was got, consists of white quartz with red jasperised veins running through it.

Commissioner's Reef is west of Martin's. It bears N. 10 degrees E. and underlies E. 10 degrees S. It is from 1 foot to 15 inches in width. Country rock a granitoid schist. A large dyke 12 feet wide of quartz felsite, running W. 35 degrees S. across the reef, stands up prominently out of the ground.

The Albion and Mariner's Reefs.—These are parallel reefs a little west of the Commissioner's Reef; the shafts were full of water, and I could gain but little information regarding them.

The Barcoo Reef is 300 yards west of the Mariner's Reef. It bears N. 10 degrees E. and has an easterly underlie. The quartz is white, and is veined with oxide of iron. Very rich patches of gold were met with. Six tons yielded 135 oz. of gold. The "shoot" of gold dips to the north with the cross-reef. Very little gold was got on this reef away from the cross-reef. The reef can be traced along the surface for over a mile in a southerly direction. It was worked by Norris at a point 300 yards north of Escort or Store Creek. This shaft is 45 feet in depth. The country rock is a fine mica schist with beds of hard quartzite, dipping S. 30 degrees W. at 40 degrees. A "shoot" of gold here dips to the south. Thirty tons of quartz from this shaft went over 2 oz. of gold per ton.

Another reef to the west of Mount Remarkable has been worked. Fourteen tons yielded 2 oz. of gold per ton, and the last crushing of 35 tons yielded 16 dwts. 17 grs. of gold per ton.

I must again point out that, though these crushings look well on paper, they are all small ones, and have been picked from the best gold-bearing "shoots." I believe, however, that plenty of payable stone exists to keep a battery on the field going for some time.

The country between Specimen Creek and Escort or Store Creek consists of mica schist and quartzite to a point about two-thirds of a mile above their junction, where there is a deep alluvial drift. This drift was tried by two series of shafts, one running N.E. and S.W. the other N.W. and S.E. Gold was obtained in some of the former series, the best being in the shallow shafts near the S.W. margin of the drift. The drift was too deep to pay working expenses, some of the holes going down 130 feet to bottom. The drift consists of a decomposed felspathic material, with layers of quartz pebbles. The pebbles, or rather boulders, at the bottom were very large.

Lead Lodes.—About half a mile E.N.E. of these shafts, on the northern side of Specimen Creek, there is a lode containing in parts a large amount of galena (sulphide of lead), and cerussite (carbonate of lead). The matrix of the lode is chiefly quartz. The lode runs W. 20 degrees N. and underlies S. 20 degrees W. at 50 degrees. The country rock is mica schist. The dyke of gabbro seen near the Bell-Gay Reef crops out again here just above the lode. Samples of the galena and carbonate ore were assayed for silver by Messrs. Coane and Clarke, Charters Towers; the results were very poor.

Sample

Sample 1, consisting almost entirely of galena, yielded 6 oz. 4 dwts. of silver per ton, and 73 per cent. of lead.

Sample 2, consisting of galena and carbonate of lead, yielded 4 oz. 5 dwts. of silver per ton, and 48·75 per cent. of lead.

A second galena lode, though not so rich in galena at the surface as the former, runs parallel, and at a few yards distant from the above. A quartz reef called the "Duchess" crosses these lodes in a direction N. 20 degrees E. Mr. Norris informed me that a crushing of picked stone taken from the shaft, which is 70 feet in depth, went 6 oz. of gold to the ton.

Behind or north-east of these lodes is a patch of Tertiary (?) conglomerate which extends nearly to the camp on Running Creek.

The country on the south side of Store Creek consists of schists for some distance back from the creek, when a ridge of quartzite occurs running in a W.N.W. direction. Graveyard Gully and Nuggetty Gully, both heading from this ridge, have been rich in alluvial gold. At the head of Graveyard Gully there is a quartz reef in conjunction with a dyke of felstone running S. 20 degrees W. I could get no trace of gold by prospecting quartz from this reef, though just below it the gully was very rich. On the southern side of this ridge, Green's, Long's, and Moran's Gullies, running into Running Creek in a westerly direction, are situated. All of these have been very rich, and they are still being fossicked over by Chinamen.

No reefs of any consequence have been found in the neighbourhood of these gullies. At the head of Nuggetty Gully a quartz reef containing crystals of schorl was tried, but it was poor, and the gold was worth only £2 5s. per oz.

Good alluvial gold was obtained in Paddy's, Sharpers', and Golden Gullies, which run in a southerly direction into Running Creek. These gullies are on the area marked as felspar porphyry on Daintree's map. The rock resembles very much at first sight a decomposed felspar porphyry, as it consists for the most part of an impure kaolin. On examining it closely it is seen to be of an ashy character, passing at times into a coarse agglomerate. The whole mass is full of minute particles of foreign rocks such as quartzite and schist. The rock comes up through the surrounding schists, and it is evidently therefore the "neck" or "pipe" of an old volcano. Towards its northern extremity the rock weathers a reddish colour, due to the amount of oxide of iron in its composition. It is bounded by Golden Gully on the east and by Running Creek on the south.

On the ridge at the heads of and separating Sharpers' Gully from Paddy's Gully, the ash is in layers alternately red and white. The surface for some distance down and alongside both of these gullies has been sluiced, and paid well. In Paddy's Gully gold was found in flat pieces about the thickness of a sixpence, lying on the rock beneath the surface rubble. The gold in Sharpers' Gully was coated with oxide of iron, giving it a black colour.

At the head of Paddy's Gully there is a claim called the *Red White and Blue*, or *Paddy's Gully Claim*. This is being worked by a party of men who have lately erected a small four-head battery. Small veins of iron-stained quartz, soft kaolin, and a hard felsitic rock, from ⅛ of an inch to 2 or 3 inches in width, run through the volcanic ash in an east-south-easterly direction. They underlie to the N.N.E. at angles varying from 35 to 60 degrees. These leaders, especially the quartz and kaolin ones, carry good gold, and pieces of gold up to half a pennyweight in weight have been found in the rock itself close to the leaders. There is no definite lode, nor is the width that may be payable to work yet known. An underlie shaft is down 80 feet on the back of the leaders, but this unfortunately was full of water, and I could see nothing of it except the first few feet. The men had left it while erecting the battery, and intended taking the water out as soon as they had put through some stone they had at grass. They tell me that gold was met with to the bottom of the shaft. At 12 feet in depth two small drives have been put in along the leaders. Stone taken from the western drive yielded 1 oz. 6 dwts. of gold per ton. The gold is worth £3 12s. per oz. The stone was crushed with wooden stampers, and then washed in a "cradle."

To the north of this area of volcanic ash, as far as Store Creek, there is a ridge of quartzite, which dips S. 30 degrees W. at 45 degrees.

The Lower Cape, or Capeville as it was formerly called, is situated on the Cape River, about 3 miles above Hawthorn Vale Station. Nearly all the workings at the Lower Cape are on what is known as the "Deep lead." This was worked first about eighteen years ago, and attracted a population of over 3,000, now the population is not over 30, including the Chinamen.

The lead has been worked in a southerly direction from the river for 2½ miles. The lead is both narrow and shallow; near the river it becomes deeper, and widens out towards the south. Near the surface the drift consists of a decomposed schistose material with pebbles of quartzite, granite, and quartz throughout it. The wash, in which the gold occurred, consists of large rounded pebbles of a glassy-looking white quartz, cemented loosely together by a schistose débris. The wash, as a rule, was from 1 foot to 18 inches, and in places as much as 2 feet in thickness. The gold was coarse, and very much waterworn and rounded, of a very different character to the more or less angular particles obtained from the gullies. The "wash dirt" went from 1 oz. to as high as 25 oz. of gold to the load, averaging nearly 3 oz. to the load.

The most northerly point at which this lead has been worked is about 300 yards south of the river, and about the same distance west of the township. The depth of the drift here was 38 feet; and then it became shallower opposite the township, being only 15 feet deep. Just north of Gahn's Flat the surface is being worked by a sluicing company. The water for sluicing is pumped up from the river flat into tanks by a small engine. The quantity of water was quite insufficient for sluicing on a large enough scale to make it pay. The returns have been very poor, with the exception of a few patches of small nuggets which were met with. The drift spreads out over Gahn's Flat, and then crosses a low ridge known as Red Hill. The depth here was only about 3 feet, and the whole of it was worked, yielding about 3 oz. of gold to the load. The drift on this hill is coloured red with oxide of iron. Towards the south of Red Hill it becomes deeper, and is about 15 feet deep. Immediately south of Red Hill is White Hill, where the drift changes quite suddenly to a white colour. From this point it gradually gets thicker, until

until at a distance of 2½ miles the shafts are from 90 to 100 feet in depth, and the lead has spread out from a couple of hundred yards to half a mile across, the gold here being more disseminated, going only about ½ oz. to the load, and the greater depth to which the shafts had to be sunk to bottom caused the lead to be abandoned. Very little prospecting has been done south of this point to ascertain whether a channel exists in which the gold would be more concentrated.

The late prospecting party which was receiving Government aid simply put down a few holes in close proximity to the old workings at both ends of the lead. To thoroughly prospect it a series of holes, connected with drives, should be put right across the drift some distance in advance of the last working places.

A few holes were put down near Murray Creek, 3½ miles south of the township, but without any results.

In wet seasons, when there is plenty of water about, men make a living fossicking over the old workings. It might pay to sluice the whole ground over if the difficulty of obtaining water could be overcome.

Large quartz reefs occur in the schists on both sides of the "lead." They are composed of a hard, glassy, barren-looking quartz.

On the northern side of the river, between a point opposite Charters Creek and Sandy Creek, known as Milkonan's Point, very rich gold has been obtained in a drift similar to the above, with the exception that granite boulders are more numerous. The drift on this flat is between 40 and 50 feet deep. A large portion of this ground is still unworked on account of the great amount of water met with. Between Rocky and Sandy Creek the "wash" went 6 oz. of gold to the load. A good deal of surfacing has been done here too.

A deep drift was worked on the south side of Sandy Creek, opposite Chinaman's Gully, about 3½ to 4 miles up above its junction with the river.

As to the age of these drifts it is impossible to say more than that they are considerably older than the alluvial deposits of the present watercourses. It is very probably a Tertiary deposit. It is impossible without a detail survey to define its extent south of Bett's Creek, but much of the country coloured Pliocene Tertiary on Daintree's map is recent alluvium.

Sandy Creek and Chinaman's Gully.—The country drained by Sandy Creek consists of hornblende and mica schists, everywhere intersected by dykes, sheets, and bosses of granite. The intrusive granite occupies as large an area as the original schists. The granite dykes are not all of the same age, as some of them are faulted by what are evidently more recent ones (*see* Fig. 3). The schists dip S. 30 degrees W. at from 30 to 40 degrees.

The hornblende schist in thin sections under the microscope shows magnificent green hornblende, with perfect cleavage, (the hornblende has a linear arrangement,) crystals of oligoclase felspar, very perfectly cleaved, and one or two crystals of orthoclase felspar. Quartz occurs, full of enclosures some of which are apatite. Small specks of magnetite also occur in the section.

Chinaman's Gully was exceedingly rich throughout its whole length. The bed of the gully is very narrow, and the gold was therefore concentrated in a small space. The gold was coarse and nuggetty. A large flat nugget of 90 oz. was found by the Chinamen, as well as several others ranging in weight from 2 to 20 oz. The gully was discovered by Chinamen, and has been worked over three successive times by them. The gold is somewhat similar to that got in a drift near the head of the gully, and may have come from there. At the time of my visit two miners were sluicing the surface on the west side of the gully. The water was conducted through a water-race 3 miles in length, from a creek at the foot of the granite range.

The rocks in the bed of the gully are quite bare. Fig. 4 is a section in the gully showing the numerous granite dykes and the local contortion of the schists which may be at times noticed in their neighbourhood. A dyke of dolerite has been laid bare by surface workings on the western side of the gully near its mouth. The dyke is about 6 feet in width, with a quartz vein running along its centre. It is running E. 10 degrees S. The dolerite shows the well-known speroidal weathering so common in basaltic rocks.

Two large "buck" quartz reefs occur, one on either side of the gully, but no colour of gold has been obtained in them.

A reef running N.W. and S.E. occurs a few yards south of the dolerite dyke. It is from 1 to 2 feet in width at the surface. Only a small hole 4 feet in depth has been put down on it. Colours of gold are showing in the quartz. A 6 oz. specimen was picked up on the reef close to the creek.

A section, seen in the southern bank of Sandy Creek, about 200 yards below the mouth of Chinaman's Gully, would suggest that some of the granite may have been the result of further metamorphism of the schists. At the top of the section is a layer of hornblende schist, below that are granitoid schists, and then another layer of hornblende schist, and lastly a pinkish granite. These rocks are dipping S.S.W. at 50 degrees. Two veins of white granite, one running north and south and dipping east, and the other N. 30 degrees E. and dipping S. 30 degrees E., intersect the whole of these rocks. (*See* Fig. 5.)

Schists and granite occur up to the heads at the foot of the granite range known as the Pentland Hills.

The granite of the range in this neighbourhood is full of small sherry-red garnets; they occur in the greatest number in that part of the rock which contains the least mica. A microscopical section of this rock is made up entirely of felspar, quartz, and garnets, with very small specks of mica.

The deep drift referred to before, situated on the south side of Sandy Creek, opposite Chinaman's Gully, has been worked to about 300 yards south of the creek, and was payable to that point. The prospecting party receiving Government aid had put shafts down on either side of the old workings, and also about a quarter of a mile south of those workings, but the results obtained were not encouraging, and they were leaving this part of the field when I arrived. The drift consists of schists and granite pebbles and boulders with a kaolin cementing material. Nodules of kaolin, called "clinkers" by the miners, occurred in the drift, and the gold was in greater quantity generally where they existed.

Between Chinaman's Gully and the Upper Cape the ordinary schists crop out along the river, from Fat Hen Creek to about 3 miles below the Upper Cape. From this point the schists are hardened and baked by intrusive granite. A dyke of olivine basalt running N.E. and S.W. is seen in a gully on the north side of the river, about 3½ miles below the Upper Cape.

Parties were sluicing the surface in one or two places about 2 miles below the Upper Cape.

The

The Upper Cape is situated about 14 miles up the river from the Lower Cape. It is about 1370 feet above sea-level.

The granite ranges come close down to the northern side of the river. Mount Elvan is composed almost entirely of granite.

The chief work about the Upper Cape has been on Daunton's Hill and Surface Hill, situated on the eastern side of Gorge Creek at the foot of Mount Elvan. Small quartz leaders running from N. and S. to N.N.E. and S.S.W., generally with an eastern underlie, though some are perpendicular, and others have a westerly underlie.

The leaders are very small, varying from the thickness of a blade of a knife up to 2 or 3 inches in width; in places they are very rich, nearly all gold. The rich "shoots" of gold generally dip to the north. The country rock on these hills consists of mica and hornblende schists, dipping S. 30 degrees W. at a steep angle, and intersected with granite veins. The leaders were especially rich when in contact with a coarse mica schist with veinlets of quartz through it which weathers a dirty brown colour. This is somewhat harder than the finer schists. They were also rich when in contact with a dyke of a peculiar hypersthene (?), rock. This rock consists of hypersthene (?) quartz, brown mica, and leucoxene. Mr. Daunton informed me that he obtained several rich patches of from 20 to 400 oz. It is here that the wire gold, locally termed "spider leg" gold, was obtained. Some exceptionally beautiful specimens of this gold have been found.

So far as work up to the present has shown, the leaders are not gold-bearing below a depth of from 30 to 40 feet, where they come in contact with hard hornblende schists. As none of the old shafts were open, I was unable to see the character of the country at that depth. Mr. Daunton tells me that he has often sunk into this rock, but with one exception has never met with any payable stone.

Surface Hill is immediately south of Daunton's, and similar conditions are met with here except that the leaders are lying much flatter. The Defiance and Lincoln leaders were rich, over 1,000 oz. having been taken from the former in one place.

Work is carried on on the very smallest leaders in this neighbourhood, as experience has shown that they often widen out to 2 or 3 inches, and are very rich indeed.

Green's Specimen Reef is situated on the southern spur of Mount Elvan, about a quarter of a mile from the river. It bears E. 30 degrees S. and underlies S. 30 degrees W. at 45 degrees, running and dipping with the strata. It is made up of a felspathic rock much decomposed, and often so full of blebs of quartz that it might be mistaken for a quartzite. Overlying this formation is granite, while below it is a fine mica schist. A tunnel 150 feet in length has been driven into the hill to cut this formation.

In the tunnel it consists of a soft kaolin material, with but little quartz. It is 11 feet in width, and throughout it are small veinlets of quartz in which the gold for the most part exists. A five-head battery was erected on the river for the purpose of working this formation, by Mr. Jackson, but the stone when put through in bulk went under 5 dwts. of gold per ton. Since then it has had no further trial. The last crushing was one of 100 tons, which went only 3 dwts. of gold per ton.

Mr. Jackson tells me that assays and prospects led him to expect at least ½ oz. to the ton, but I expect stone containing portions of the quartz leaders was principally tried. The veinlets of quartz are so small that they could not be picked out. Wire gold was found here too.

The formation is a sheet of felspathic rock, probably a porphyry, or a highly felspathic granite, which has decomposed near the surface into kaolin. A dyke of granite runs through the schists in a N.W. and S.E. direction.

On continuing up the spur a hard actinolite schist is passed over, and then a fine-grained granite up to the summit of Mount Elvan, which is 600 feet above the river, or 1,970 feet above sea-level.

Payable gold has been got in most of the gullies around Mount Elvan. Three "leads" have been worked at the Upper Cape.

The Canton Lead is situated on the western side of Gorge Creek. It runs in a direction W. 35 degrees S. from a small gully called Little Bargoo Gully. The gold got in this gully was of the same character as that in the "lead." At the mouth of this gully the same hypersthene rock dyke crops out that is met with on Daunton's Hill. Payable gold was taken from surface workings at the head of the "lead." The breadth of the lead near its head is about 30 feet, and its depth about 15 feet. The country on both sides of it is schist. Further down, where it junctions with a branch lead from Surface Hill, it is 100 feet in breadth.

The drift consists of flat pebbles of schist, and rounded pebbles and boulders of granite. It has a horizontal stratification. The "wash" at the bottom consists of much coarser pebbles. The gold was chiefly wire-shaped.

It has been worked entirely by Chinamen; they were sluicing it away in a face of about 25 feet in depth at the time I was there. The branch "lead," heading from Surface Hill on the eastern side of Gorge Creek, was being sluiced by Daunton and party in Daunton's Gully. It is only in rainy seasons such as that of last year that water can be procured for sluicing purposes.

The Pot-Hole Lead is situated a little over a mile below the Upper Cape, on the south side of the river. In the river at the mouth of the "lead" there is an intrusive felspar porphyry of a reddish chocolate colour, which in thin sections under the microscope show an undistinguishable groundmass having a flowing structure, full of ferrite and magnetite, and containing porphyritic crystals of oligoclase felspar. This rock extends for over half a mile down the river.

Close to the river the drift is only 12 feet in thickness. The wash contains large boulders of granite, some of them over 2 feet in diameter. Pebbles of red oxide of iron occur in the drift, and are looked upon as a good indication of the presence of gold. Two hundred yards south of the river the average depth of the shafts is 30 feet. A few pebbles of olivine basalt occur here, and also small pieces of rounded olivine, called "green painters" by the miners, which are said to be a certain indication of gold in the wash. The presence of the basalt points to the fact that the drift must be of a great age, as no basalt occurs in the district now, with the exception of the dyke before mentioned, and that on Mount Black, about 6 miles up the river from here. The basalt pebbles are probably the detritus of the basaltic outflow of which the small patch on Mount Black is now the only remnant. The other materials of the drift are similar to those in the Canton Lead.

The Bluff Lead was being worked by Chinamen about a quarter of a mile north of the above. It is of the same character as the drift deposits. The

The country about here is of the ordinary schists, the quartzite ridges are here about 5 miles south of the river. Some reefs have been worked 2 or 3 miles S.S.W. of the township.

The Harp of Erin Reef.—This reef is situated about 2 miles S.S.W. of the Upper Cape. It bears north and south, and underlies to the east. It is in mica schist, much intersected with granite dykes. The shafts were full of water. This reef was worked in the early days. I could obtain no information as to the actual results of the crushings, though Mr. John Houghton, who kindly acted as my guide, informed me that it crushed well. The quartz is cellular, and somewhat crystalline, and is coated with oxide of iron. It contains a little galena and pyrites in places. Shotty alluvial gold was taken from a gully just below the reef.

The Wheel of Fortune Reef is situated a mile nearly due south of the Harp of Erin Reef. It bears N. 30 degrees E. and underlies E. 30 degrees S. The country consists of schists and quartzite, intersected with granite veins. The shaft is down 90 feet in depth; it was full of water. The quartz near the surface contains pseudomorphs of iron pyrites in oxide of iron; at a lower depth it contains iron pyrites. Mr. Houghton informed me that many tons were crushed from this reef, both at Jackson's mill at the Upper Cape, and also at Charters Towers, giving an average return of 3 oz. of gold to the ton. When the pyrites was reached the reef was abandoned.

The Occidental Reef bears S.W. and N.E. and underlies S.E. It consists of very crystallised quartz. The shaft, which is full of water, was down 90 feet in depth. There are specks of galena in the quartz. The country consists of mica and hornblende schists. The granite veins are not so numerous as at the other reefs.

These reefs are situated in low ridgy country.

Four miles up the river from the Upper Cape, Mount Richardson stands out by itself on the south side of the river. It consists entirely of fine-grained mica schists, with a few dykes of granite running in a north and south direction. Its summit is 1,940 feet above the sea-level. About a mile south of Mount Richardson is the long quartzite range which runs from Mount Miller to near Mount Remarkable.

Following up Reedy Creek, which junctions with the river on its northern side, opposite Mount Richardson, the country is chiefly granite, with here and there bands of highly crystalline schist. There was a small rush of miners to work a gully and some small leaders on the range, about 5 miles up the creek. A miner had been working here for two or three years, and at the time of my visit twenty men were there, having found out his whereabouts. The leaders are very small, but carry coarse gold, and payable gold was being got in the gully.

A band of highly crystalline schist runs from this gully to Gorge Creek near the Upper Cape, the country all the way being very precipitous and rugged.

From the Upper Cape I went up the river to Coolemen Station, a distance of 10 miles, where I stopped to examine Mount Black. Coolemen Station is 1,545 feet above the sea-level. Mount Black is situated about 3 miles nearly due south of the station. On ascending the hill on its northern side, the first 350 feet or so is well grassed and covered with the ordinary forest trees, the rock being schists which dip at a steep angle to the S.W. Capping the schist is an olivine basalt about 200 feet thick, the base of which is dipping to the south, the basalt being much lower down the mountain on the southern side. (*See* Plan No. 1.) With the exception of a few plum and bottle trees there is no vegetation at all growing on the basalt. The basalt has a columnar structure, some of the columns being almost regular hexagons and of great length. The rock is highly magnetic, and had a great effect on the needle of my prismatic compass. I found that magnetic polarity existed even in hand specimens of the rock. Professor Hull, in a paper read before the Royal Society on 16th May, 1889, on the origin of terrestrial magnetism, alludes to polarity in basalt. He thinks it due to a polar arrangement of the crystals of magnetite, which crystallised out from the magma while the latter was in a viscous condition. The magnetite would necessarily assume a polar arrangement which would be one of equilibrium. The basalt of Mount Black is full of small specks of magnetite. The only question which occurs to me with reference to Professor Hull's explanation is, whether magnetite at the temperature of viscous basalt would not have lost its magnetism, as magnetite heated to a white heat has no effect on a needle.

This is the only patch of basalt left in this district of what once must have been a large outflow of lava.

Zeolites occur in cavities of the basalt left.

Gold has been found in the gullies to the west of Mount Black in quartzite country. The quartzite ridges occur immediately south of the mountain.

The granite ranges come down close to Coolemen Station.

From Coolemen I followed the river up to its head, and crossed the range on to the Flinders waters, and camped on Oxley Creek. The country for the whole distance consisted of schists dipping from S. 30 degrees W. to S.W., with the exception of a patch of granite at the foot of the range.

Oxley Creek runs into White Mountain Creek, which is a tributary of the Flinders River. The height of my camp above sea-level was about 2,000 feet. The rock all the way down the creek consists of hard quartzose schists of a bluish colour. For two miles down they dip S.W. at angles from 30 to 10 degrees; beyond that point they dip to the N.E. The schists are full of veins of quartz which are faulted in all directions.

Many of the gullies running into Oxley Creek have been worked; among these may be mentioned Italian, Jackson's, and Butcher's Gullies. In Italian Gully the gold was coarse and rounded, one nugget weighing 17 oz. In Jackson's it was not so waterworn, and is generally found as "specimen gold"—that is, gold attached to quartz. Gullies have also been worked a few miles above the camp.

Sneakaway Gully, heading from Mount Courtenay, which is 4 miles a little north of west of the camp, was worked for 500 yards or so down from the mountain, but beyond that it was not payable. The gold was attached to a bluish tinted quartz. A reef of similar quartz occurs at the head of the gully, but I could find no trace of gold in it. The mica schist and quartzite in this gully dip N. 35 degrees E. at 25 degrees. Mount Courtenay consists chiefly of quartzite and mica schist. Its summit is about 2,620 feet above sea-level.

The gullies here were too patchy to be payable, and there is now only one man at work on them. No reefs have been worked in this neighbourhood. The schists in the lower part of Scrubby Creek, Oxley Creek, and Little Oxley Creek, are dipping to the N.E., a synclinal axis running across the country in a nearly north-west direction.

GRANITE.

An immense area of granite stretches away to the north of the schists. It extends as far north as Lolworth Creek, and eastwards past Charters Towers to the coast. Along the coast it extends from Halifax Bay to the north to Broadsound on the south—a distance of over 350 miles. It is natural that, covering such a large area, the character of the granite should change to a great extent, both in texture and mineralogical constituents. Over the area traversed by me it changes from a typical micaceous granite into syenitic granite and porphyry of every degree of fineness. At the head of Sandy Creek, which runs into the Cape River just above the Lower Cape, it is full of small crystals of garnet.

The Pentland Hills form the watershed between the Cape River and the Homestead Creek and other creeks running into the Cape.

With reference to the age of the granite, there is no evidence, except that it is of more recent date than the schists, as is shown by bands of hardened schists occurring in the granite; while near the junction of the two rocks the granite sends out dykes and veins into the schists.

The granite is intersected in places by dykes of porphyry and diorite

The old Homestead reefs (described later on in this report) are situated in the granite. Some of these reefs gave very good returns down to a certain depth.

The Broughton reefs, Rishton reefs, Livingstone reefs, and Dreghorn reefs are all situated within the granite area, as also is the Charters Towers Gold Field itself.

THE DESERT SANDSTONE.

I first met with rocks of the "Desert Sandstone" in Betts Creek, about 5 miles south-west of my camp, near Mount Remarkable. I have left the description of those rocks until I come to describe the Desert Sandstone formation in the neighbourhood of White Mountain Creek and Walker River, as the Flinders is called there.

Crossing from Paddy's Gully to Betts Creek there is an alluvial deposit made up of quartz, quartzite, and schist pebbles, cemented together by a clayey material.

Following up Betts Creek to within about a mile of Conglomerate Gully, high banks of sandstone and shale are seen on the southern side of the creek. The sandstone at the base is 15 feet thick. It is a coarse, white sandstone, with layers of quartz pebbles in it, like that generally met with in the Desert Sandstone rocks. Above this there is a layer of shale, and then alternate white and brown mud rocks. Above these is a bed of sandstone, and then a thin bed of shale full of *Glossopteris* leaves. Above this again is sandstone (*see* Section, Fig. 6). The height of the bank is 40 feet. The beds are almost horizontal. I fortunately had an opportunity of submitting these fossils to Mr. R. Etheridge, junr., who pronounced them to be undoubtedly *Glossopteris*. From the character of these beds, and also from the stratigraphical position of similar beds seen in the railway cuttings on the range beyond Pentland towards Hughenden, where they certainly overlie the rolling downs formation, I would pronounce them to be Desert Sandstone.

If this is the case, however, then the plant *Glossopteris* must have a much longer range in time than has hitherto been suspected, as it was supposed to be confined to the Palæozoic rocks, or at most to range as high as the Lower Mesozoic. Mr. Etheridge has determined the supposed *Glossopteris* of the Burrum coalfield, and of Stewart's Creek, near Rockhampton, to be a form of *Tæniopteris*.

Unfortunately, on account of the boggy nature of the ground, I was unable to camp in this neighbourhood, and to examine into the stratigraphical relations of these rocks more minutely.

At the mouth of Conglomerate Gully is the following section:—

	Ft.	in.
White sandstone	6	0
Fine white sandstone	1	0
Coarse sandstone, with layers of quartz pebbles	5	0
White sandy clays	1	6
Fine-grained laminated sandstone	3	0
Coarse conglomerate	5	0

About half a mile further up the creek another section is showing. The beds here dip to the south at 10 degrees.

	Ft.	in.
Clays	6	0
Laminated sandstone	2	6
Coarse sandstone	3	0
Laminated sandstone and clay	1	9
Coarse sandstone and conglomerate	2	0
Fine white laminated sandstone and shale	5	6

Up Conglomerate Gully high bands of sandstone and conglomerates occur on both sides.

The country is very barren and badly grassed; it is covered with lancewood timber.

At the mouth of Oxley Creek bold cliffs of white sandstone occur, which extend away in an east-south-easterly direction. The cliffs here are about 300 feet in height.

In the bed of White Mountain Creek, opposite the mouth of Oxley Creek, there is a bed of brown shale in which the plant *Calamites* occurs in great numbers. Above the shale the rock consists almost entirely of coarse white sandstone with layers of quartz pebbles, and also thin beds of shale and conglomerate. *Calamites* occurs again in an iron-stained sandstone higher up the cliff. Near the junction with the schists these beds are dipping S.W. at 25 degrees, but further in they are horizontal.

These beds extend away down to Betts Creek, crossing the railway line at the range. They can be seen as far as eye can reach from Mount Black and the range behind Mount Black.

White Mountain Creek has cut a deep channel through the sandstone from Oxley Creek to its junction with the Walker or Flinders River, a distance of about 3½ miles.

Following

Following up Walker River, where the stream has cut a somewhat narrow channel or cañon 200 feet in depth, through the Desert Sandstone, and the basalt which here overlies it. The Desert Sandstone consists of a coarse thick-bedded sandstone, with layers of quartz pebbles, beds of conglomerate, and thin beds of shale. The sandstone shows false-bedding in parts. The overlying basalt is about 50 feet in thickness. (*See* Fig. 7.)

About 2½ to 3 miles up the river from the junction of White Mountain Creek, the desert sandstone is seen faulted against the schists by a fault running E.S.E. and dipping S.S.W. The schists and desert sandstone are both covered with basalt. The desert sandstone is bent up near the fault, and is dipping S.S.W. The section is well seen in the bank of the river. (*See* Fig. 8.)

BASALT IN THE NEIGHBOURHOOD OF OXLEY CREEK AND THE WALKER RIVER.

To the west of the Walker River is a vast tableland of basalt extending for many miles. Remnants of this basaltic tableland occur on the east side of the river, between it and Oxley Creek, forming "outliers" which have been separated by watercourses. The remainder of this basalt has been entirely removed by denudation. The cavities in the basalt are full of zeolites. Thin sections of the basalt under the microscope shows it to be made up of a groundmass of small interlaced crystals of felspar, with crystals of olivine throughout it. The olivine crystals are much decomposed, especially around the margins of and along the cracks in the crystals. It contains very little magnetite.

This basalt is clearly of Tertiary age, overlying, as it does, the Desert Sandstone.

From Oxley Creek I travelled towards Lolworth Station, passing Mount Three Heads, which forms the junction point of the three ranges dividing the Cape, the Flinders, and the Fletcher waters. The summit of Mount Three Heads is about 2,428 feet above the sea-level. It is composed of schists. Two miles beyond the mountain in a north-easterly direction granite comes in, and that rock is traversed as far as Lolworth Creek. On the north side of the creek a large area of basalt overlies it.

Close to Lolworth Station there are two peaks of granite forming "inliers" coming up through the basalt.

The thickness of the basalt at Lolworth Station is not more than 15 to 20 feet. A spring of water comes up through the basalt, forming a stream which runs past the station, and which is never dry, not even in the longest droughts. Water would be found almost anywhere here by sinking through the basalt to the granite below.

The southern boundary of the basalt may be taken roughly as following Lolworth Creek, though it crosses it in places.

About 2 miles N.N.W. of Lolworth Station, a hill of mica schist comes up through the basalt, and about a mile further on a second "inlier" of schist occurs, showing that the boundary of the granite and schists occurs under the basalt, not far north of Lolworth Station.

On my way to Homestead, I had an opportunity of examining the "Great Basalt Wall," which is shown on all the maps of the colony. It runs along in an east and west direction, at a distance of from 2 to 6 miles north of Lolworth Creek. The basalt is highly scoriaceous. Everywhere the cracks produced in the rock on cooling are visible, and there are immense spheroidal-shaped masses in it also produced by cooling. The lava must have outflowed in a semi-viscous condition, for the well-known "ropy" structure, formed by masses of semi-liquid lava rolling over and over, is very conspicuous; this structure is easily seen, even in hand specimens. The basalt consists of a groundmass of small felspar crystals with specks of augite (?) and magnetite.

The basalt does not form a wall in the ordinary sense of the word, that is to say, there are no perpendicular cliffs of it, but it gradually rises in steps getting thicker and thicker as it recedes from the margin. It is destitute of any vegetation, with the exception of some plum and bottle trees, and a few other scrub trees. I was informed by Mr. Clarke, of Toomba, that he has discovered some miles of well-grassed open country in the middle of this basalt. Its average breadth is about 8 miles. Its general appearance is that of a recent outflow of lava, and it probably represents the latest outflow in the district.

Just before crossing Lolworth Creek, about 12 miles from Toomba Station, a small "inlier" of granite rises through the basalt. Basalt occurs all the way to Toomba, and also as far as Hann's Creek, on the way from that place to the Old Homestead Diggings.

There are a number of swamps and lagoons in the basalt country between Lolworth and Toomba. Toomba Lake is simply one of the lagoons on a large scale. It is over 2 miles in length, and about a mile in breadth in its widest part.

Old Homestead Diggings.—These diggings are situated about 8 or 9 miles north of Homestead, and 15 miles south of Toomba Station. They are in granite country, with here and there bands of schist. With the exception of Main's Reef, which is just being opened up, all the reefs are abandoned.

Main's Reef.—This reef is near the foot of the range, and is on the eastern side of the gully running in a southerly direction into Homestead Creek. It bears N. 10 degrees E. and is perpendicular. The country is a coarse pink granite, with white mica. The reef consists of quartz containing sulphides and carbonates of copper, a little galena, and iron pyrites. It is from 2 to 4 feet in width. I got very good prospects from stone containing galena and carbonates of copper. The prospects from other parts of the reef were small. A crushing of 6 tons had just been put through, which yielded 4 oz. 9 dwts. of gold, or about 15 dwts. per ton. The following assays of pieces of stone were made at the School of Mines, Ballarat, with the following results:—

	Oz.	dwts.	grs.				Oz.	dwts.	grs.		
1.—	1	17	5	of gold per ton, and			5	7	9	of silver per ton.	
2.—	0	13	6	„	„	„	0	15	6	„	„
3.—	2	10	7	„	„	„	1	19	4	„	„
4.—	10	12	13	„	„	„	3	3	9	„	„
5.—	7	2	0	„	„	„	8	9	0	„	„

The other reefs are from 2 to 3 miles south of the above.

The

The High Bar Reef.—This reef bears north and south. The P. C. shaft is down 130 feet. From the bottom of the shaft solid masses of mispickel (arsenical pyrites) were obtained. The last crushing of 40 tons went only 4 dwts. of gold per ton; near the surface some of the stone went 2 oz. of gold per ton. At the P.C. shaft there are bands of chloritic schist in the granite, while the reef in the No. 5 South Claim is in a fine diorite.

The Whistling Tom Reef is a parallel reef, situated about a quarter of a mile east of the above. It underlies steeply to the east. There have been no crushings from this reef. Thirty ounces of gold in specimens occurred in the reef near the surface. The country rock is intrusive granite in schists.

Klasted and Party's Reef is 2 miles east of the High Bar Reef. It bears N.N.E. The country consists of a coarse granite containing large plates of white mica, with numerous bands of crystalline schists striking E. 10 degrees N., and much contorted. The surface stone averaged over an ounce to the ton, but lower down it only went 5 dwts. of gold per ton.

Denison's Reef is north of the above. It is about 1 foot in width, and of the same character as the others. The last crushing went 19 dwts. of gold per ton. About half a mile west of this again there is a large reef running N.N.E. It is 3 feet in width, consisting of white quartz with veinlets of oxide of iron through it. The country is a crystalline schist. A crushing at Charters Towers went 2 oz. of gold per ton. In prospects I tried there were only fine colours.

Lind and Party's Reef.—This reef bears N. 5 degrees W. It was about 2 feet in width in the shaft, which is 60 feet deep. Thirty tons of stone from this reef and one 200 yards to the east went 1 oz. of gold per ton. The country is granite. Good alluvial gold was got in a gully near these reefs.

A battery was once at work on the field near the Chinaman's Camp, about a mile south-west of the last-mentioned reefs.

The reefs are all of a fair size. Judging from the position of the shafts, the best "shoots" of gold appear to be near where the granite is in contact with beds of schist. The country was originally all schist, but now the granite occupies a larger area than the original rock.

About half a mile west of the Homestead Railway Station a small quartz reef occurs in clay schists, which are dipping S. 10 degrees W. at a high angle. It is on the north-east side of a low hill of schist, which stands out by itself from the surrounding alluvial country. I obtained small prospects of gold from it.

The New Homestead Diggings are situated about 7 miles E.N.E. of Homestead Station, and about 3 miles E.S.E. of the 122-mile peg on the railway line. These reefs were discovered about two years ago by Mr. Howson. The country is quite flat, and consists of clay schists covered over by a thick surface soil. The reefs were traced by small pieces of quartz lying on the surface. A spur of clay schist, with a dyke or sheet of quartz porphyry along its ridge, runs in a north-westerly direction from here across the railway line. So far the returns from the crushings have been very good, and the reefs here promise to turn out well, and to prove permanent, as payable gold is being obtained at depths of from 60 to 100 feet.

The Agnes Howson Reef is, so far, the principal reef on these diggings, and its prospects are exceedingly good. It runs nearly north and south, and is perpendicular for a few feet down, and then underlies slightly to the west. The stone is a white somewhat crystalline quartz, containing specks of iron and copper pyrites and galena. The reef varies in width from 2 feet 6 inches to 4 feet. There are two shafts on this claim, down 45 feet and 60 feet respectively. At the bottom of the former—the northern shaft—the reef is 4 feet wide; in the southern shaft it is 2 feet 6 inches wide. The quartz in the paddock was showing gold throughout. I tried some quartz, showing no gold to the naked eye, and obtained very good prospects.

The following are the crushings from this reef. (The stone was crushed at Charters Towers) :—

			Oz.	dwts.			Oz.	dwts.	grs.	
1.—	12	tons yielded	9	12	of gold, equal to		0	16	0	per ounce.
2.—	25	„	60	0	„	„	2	8	0	„
3.—	100	„	152	5	„	„	1	10	10	„
4.—	40	„	102	15	„	„	2	11	9	„

In all 177 tons have been crushed for 324 oz. 12 dwts., or an average of 1 oz. 16 dwts. 16 grs. of gold per ton. The average value of the gold is £3 4s. per ounce.

About two-thirds of a mile south of the Agnes Howson Reef, a big reef has been traced in a north-westerly direction for over half a mile. This reef gave fair prospects. A trial crushing has lately been taken out of 15 tons, it yielded 2½ oz. of gold to the ton, but the gold was only worth £1 17s. 6d. per oz.

The Ada Reef is west of the Agnes Howson. It bears north and south, and underlies a little to the west. The quartz is very crystalline. The country rock is slate. Forty tons yielded 1 oz. 5 dwts. of gold per ton.

The Wild Scotchman Reef is 100 yards east of the Ada Reef. It is a highly crystalline quartz reef with gold visible in it. Seven tons yielded 28 oz. of gold.

The Callaghan Reef is probably a continuation of the Wild Scotchman. It bears north and south. The slate is dipping south-west. The reef towards the northern part is only 7 inches in width.

The Evening Star Reef lies south of the Ada Reef. It bears W. 30 degrees N. and underlies steeply S. 30 degrees W. The reef is made up of a number of quartz leaders running through the slate. Rich gold was obtained near the surface, but it was poor at a depth.

From Homestead I travelled along the railway line to Glengalder Railway Station at the 115-mile.

At the back of Lamond's selection, on the north side of the railway line, there is a coarse-reddish-brown sandstone ridge. It is doubtful whether this sandstone belongs to the Tertiary or Desert Sandstone period, but for the present I have coloured it on the map as Desert Sandstone. The country between Lamond's and this range is of a coarse granite.

About a quarter of a mile west of Lamond's, mica and hornblende schists are cropping out in a gully; they dip to the south and are intersected by dykes of granite.

The Lissner Reef is situated about 7 miles W.N.W. of Lamond's selection. The intervening country is granite, except where it is covered by the Desert Sandstone.

The reef is perpendicular and bears N. 15 degrees E. The quartz is very cellular, and is often coated with black oxide of manganese, and contains a little iron pyrites.

In the main shaft, 82 feet in depth, the reef has a slight westerly underlie. Gold is showing freely in the cellular quartz, taken from a depth of about 60 feet. Near the bottom of the shaft the character of the reef has changed, and it consists of a granitic mullock full of small cubes of iron pyrites. The reef averages about 2 feet in width. The country is granite. Trial crushings were:—

1 ton yielded 4 oz. of gold to the ton.
4 cwt. yielded at the rate of 10 dwts. of gold to the ton.

From Lamond's Siding I followed the railway line to Charters Towers. The country was alluvial flats for some miles, the only sections being at the 90¼ to the 90¾, where a coarse sandstone and conglomerate overlies the granite.

From Charters Towers I proceeded to Mount Leyshon, chiefly with a view of reporting upon the probability of obtaining a supply of artesian water anywhere in the neighbourhood.

Mount Leyshon itself is situated about 17 miles due south of Charters Towers. The road for the whole of this distance passes over granite, with here and there a dyke of diorite. On approaching Mount Leyshon the granite is replaced by porphyry.

Immediately to the south of Mount Leyshon slates crop out in the gullies, and similar slates also occur to the north of Mount Wallaby, west of Mount Leyshon.

These rocks are of so compact a nature as to be wholly impervious to rain water, and the probability of artesian water being found anywhere in this neighbourhood is very remote indeed. As far as the Mount Leyshon Mine is concerned, the manager, Mr. J. G. West, informs me that if the large dam which has been constructed across Greasy Bill's Gully, about 30 chains north of the battery, runs dry, he thinks he will be able to obtain sufficient water for the machinery from a well situated between the two branches of a creek about a mile north of Mount Leyshon, on the Charters Towers road.

In giving a short description of the Mount Leyshon Mine, it will be unnecessary to go into its geological structure, since Mr. Jack in his report* went thoroughly into that question, and pointed out that it was the deep-seated "neck" of a volcano, an opinion which is quite borne out by the work since done.

The main tunnel is situated near the northern boundary of Gold-mining lease 949. It runs into the mountain in a south-westerly direction, and is 390 feet in length. The first 150 feet of the tunnel is in a decomposed kaolinized rock, which much resembles porphyry; in it are sparsely-scattered angular pebbles and rounded nodules of a porphyry rock. Then for 20 feet there is a kaolin clay dipping south-west at 40 degrees; next to that is 6 feet of a rock similar to that at the mouth of the tunnel; and then 20 feet of the same rock, but coated with efflorescent sulphate of copper; the next 18 feet is a vesicular rock like a porphyry. Then for 84 feet is a rock resembling a vesicular quartz and felspar porphyry, containing angular pebbles, ferruginous in places, with veins of oxide of iron and oxide of manganese running through it. This rock is also coated in parts with efflorescent sulphate of copper. On the south-east side of the tunnel, and running parallel with it, is a vein, 2 inches in width, of sulphuret of copper rich in gold, dipping steeply to the south-east. Next to this is 15 feet of conglomerate, the pebbles of which are a hard quartz porphyry. These pebbles may have been rounded by attrition when falling back into the fissure or neck after ejection. The layers of rock here dip steeply to the S. 10 degrees E. From this point to the end of the tunnel, a distance of 80 feet, there is a rock resembling a quartz porphyry, but full of angular pebbles and nodules.

The workings themselves are too complicated to describe without well prepared plans of the mine, as they follow the gold-bearing portions of the rock. The ground in places is being taken out in huge chambers, the roofs of which are supported by the form of timbering known as "pigsty" timbering.

The gold occurs in layers or bands of the rock, very similar to the surrounding rock, except that they contain more veins of the oxides of iron and manganese. These layers are termed lodes, but they are not lodes in the true sense of the term, they are simply portions of the rock impregnated with gold. There are also veins of kaolin which carry gold. This kaolin, under the microscope, shows some very interesting minerals, amongst which is a green mineral, probably olivine. Often there is no line of demarcation between the auriferous and non-auriferous rock, and it is only an experienced eye that can pick out that which is likely to carry payable gold. In some parts, however, there are clearly defined walls.

The auriferous bands discovered up to the present are three in number. They run in a nearly N.E. and S.W. direction, and dip at a low angle to the south-east. The gold does not run evenly through these layers, but occurs in "shoots," which run diagonally across them in an east and west direction. These layers or dykes have a step-like appearance, caused by small faults running N.N.W. and throwing the country down a few feet to E.N.E.

A large amount of pyrites occurs in the rock at a depth, and this stone is not payable. I understand that no payable gold has been obtained below a certain depth.

The Mount Leyshon gold averages in value £2 12s. per oz. The machinery consists of a 20-head battery, jiggers, berdan pans, settling vat, and a buddle.

Mount Mawe, which is situated a few chains to the east of Mount Leyshon, is a separate volcanic "neck."

At Wallaby Point, nearly 1½ miles a little west of south of Mount Leyshon, a tunnel is being driven in a similar rock to that at Mount Leyshon. This is a continuation of the Mount Leyshon "neck." Some coarse gold, coarser than any got at Mount Leyshon, has been found in driving the tunnel. The breccias here contain angular particles of slate, derived from the surrounding country.

One

* Report on the Gold Deposits of Mount Leyshon by R. L. Jack, Government Geologist. Brisbane, By Authority, 1885.

One or two small reefs have been fossicked about 2½ miles south and south-east of Mount Leyshon.

Between Mount Leyshon and the Bluff Station—a distance of 14 miles—the country is all granite.

The Bluff consists of a coarse sandstone which overlies the granite. It is made up of a granitic débris of quartz, felspar, and mica, held together loosely by a kaolin cement. The rock weathers to a reddish colour. The thickness of the sandstone is about 120 feet, and it rises up in nearly perpendicular cliffs. It extends some miles in an easterly direction, and thins out to the south. It belongs in all probability to the Desert Sandstone period. About a mile S.S.E. of the Bluff Station the Livingstone Reefs occur in granite country.

The Livingstone Reef.—This reef bears east and west, and underlies to the north at 30 degrees.

200-feet Level.—Along the western drive at this level the reef averages about 18 inches; in places it is as much as 3 feet in width. The foot wall is a coarse grey granite. On the hanging wall of the reef a dyke of much altered rock (probably a diorite) runs parallel with the reef. Dykes of diorite, too, cross the reef in a direction N. 10 degrees E. The quartz contains some iron and copper pyrites. A little "stoping" has been done from this level.

300-feet Level.—The quartz in this level contains galena, in addition to the iron and copper pyrites. The width of the reef is from 2 to 4 feet. The dyke on the hanging wall is of a serpentinous character, with chlorite facets.

500-feet Level.—The reef here is small and broken. The quartz is mixed with a quantity of calcite.

The country rock is a syenitic granite. The reef gives very poor returns indeed, and no crushing is going on. The machinery consists of a 15-head battery, 12 berdan pans, and buddles. The machinery is lying idle.

The Lady Alice Reef is running nearly east and west, and underlies to the north. The shaft was down 200 feet. The workings are abandoned.

Another reef is situated half a mile to the N.E. of Mount Deane. It is in a felspar porphyry—Mount Deane is composed of that rock. The quartz contains a large amount of oxide of manganese. I could get no information as to the returns from these two reefs.

Don Robbin Reef.—This reef bears E.N.E., and underlies N.N.W. at 35 degrees. It averaged 14 dwts. of gold per ton. The last crushing of 80 tons went 10 dwts. of gold per ton. This crushing was taken between the depths of 55 and 90 feet. The average value of the gold from these reefs is £2 14s. per oz.

From the Bluff I went to the Dreghorn Diggings, *viâ* Cardigan Station. The country rock was granite the whole way. The Dreghorn Diggings are situated about 24 miles east of the Bluff, and 4½ miles from the Burdekin River. This is entirely a reefing country. No alluvial gold has been worked.

The Ellen Boss Reef bears N. 25 degrees W. and underlies W. 25 degrees S. at a steep angle. The main shaft, which is now abandoned, was down 145 feet in depth. Six tons of mundic stone from the bottom of this shaft only went 4 dwts. of gold per ton. Near the surface, however, it was very rich.

In a new shaft which is being sunk the reef is only 6 to 7 inches in width, with veins of hematite through it. The gold is fine, and the prospects I tried were poor. With reference to this reef Commissioner Gill reported in 1874—"The reef is about 3 feet wide in the face at 40 feet from the surface; from that up the reef is from 6 to 7 feet wide of a red stone."

The Currency Reef is about half a mile south of the Ellen Boss. There are two shafts about 30 feet apart, and each is about 86 feet deep. The reef runs N. 30 degrees W. and is nearly perpendicular. The quartz contains iron pyrites and galena, and somewhat resembles stone from Charters Towers. The workings are abandoned for the present. I was informed by one of the late owners that it averaged 2 feet in width. The country rock is granite, with an altered dyke rock running parallel with the reef. The upper portion of this reef was very rich indeed. A dyke of diorite runs across this reef.

Mr. Gill, the Commissioner, reported in 1874 that "the reef was 3 feet in width at 30 feet from the surface of nice red stone, and that there were 1,000 tons at grass, estimated to go over 1½ oz. of gold to the ton."

The Clinker Reef is about a mile north of the Currency. It is a small reef, only about 2 inches in width. It crushed about 2 oz. of gold to the ton.

The Queenslander Reef.—This reef is about 3 miles north of the Currency. It is from 8 to 18 inches in width. It crushed well near the surface. The shaft was discontinued when the mundic came in. The reef was only 4 inches wide at the bottom of the shaft (70 feet).

The Albion Reef lies between the Queenslander and Currency reefs. It is only a small leader, and averaged about 1½ oz. of gold per ton.

The Overland Reef is situated about 3 miles north-east of Dreghorn, between Dreghorn and the Burdekin River.

The reef bears N.E. and S.W., and underlies at a steep angle to the S.E. In the old abandoned shaft it appears to be about a foot in width near the surface. The quartz contains copper pyrites, and it and the micaceous granite of which the country is composed are stained with green carbonate of copper.

COPPER LODE.

A lode running N. 35 degrees W. was tried for copper near the eastern boundary of the Cardigan Block No. 2, and about south-west of the Currency Reef. The ore was not rich enough to pay.

In Oaky Creek, which runs to the west of this lode, sections of hardened sandstone and slate are showing, which "strike" east and west, and dip to the south. I made a prolonged search in these rocks, but could discover no fossils.

I was informed that the reefs at Dreghorn were deserted when the Palmer rush broke out, and they have never been worked to any extent since.

The

The following crushings have taken place at the small mill on the field during the last two years. The results have been very poor :—

Reef.	Worked by—	Date of Crushing.	No. of Tons.	Total Yield of Gold.	Yield of Gold per Ton.	Description of Stone.
				Oz. dwts. grs.	Oz. dwts. grs.	
Ellen Boss ...	Banan and Party ...	25-7-89	28	22 0 0	0 15 17	Surface.
Ditto ...	Cummings	28-9-89	18	4 11 15	0 5 1	Surface.
Ditto ...	Drewery and Pugh ...	3-10-89	10	26 1 16	2 12 4	Surface.
Ditto ...	Banan and Party ...	30-11-89	4	1 15 0	0 8 18	Surface.
Ditto ...	Joyce	1-12-89	3	4 14 0	1 11 8	Surface.
Ditto ...	Drewery and Mate ...	17-12-89	8	12 17 0	1 12 3	Surface.
Ditto ...	Hart and Coots ...	18-12-89	7	14 18 0	2 2 13	Surface.
Ditto ...	Morris	19-12-89	5	2 16 0	0 11 5	Surface.
			83	89 15 7	1 1 15	
Hidden Treasure	Best	5-10-89	7	6 18 18	0 19 19	Surface.
Ditto ...	Best	20-12-89	7	6 1 0	0 17 7	Surface.
Ditto ...	(?)	18-7-90	5½	3 4 0	0 11 5	Surface.
Ditto ...	Quinn	19-7-90	9	3 16 0	0 8 10	Surface.
Ditto ...	Cummings	21-7-90	4	2 13 11	0 13 19	Surface.
Ditto ...	Joyce	22-7-90	4	2 10 0	0 12 12	Surface.
			36½	25 3 5	0 13 18	
Queenslander ...	Blutcher and Party ...	12-10-89	20	52 10 0	2 2 11	Surface and mundic.
Currency ...	Banan and Party ...	14-11-89	18	4 15 0	0 5 6	Mundic.

The following crushings were reported by Commissioner Gill on the 24th October, 1874, as taking place in the years 1872 to 1874 :—

Reef.	No. of Tons.	Total Yield of Gold.	Yield of Gold per Ton.
		Oz. dwts. grs.	Oz. dwts. grs.
Ellen Boss	63	93 10 0	1 9 16
Ditto	21	30 10 0	1 9 1
Ditto	12½	16 0 0	1 5 15
Ditto	8	20 0 0	2 10 0
Ditto	11	29 11 0	2 13 17
Ditto	55	137 10 0	2 10 0
Ditto	136	200 0 0	1 9 10
Ditto	27	40 0 0	1 9 15
	333½	567 1 0	1 14 0
Albion P.C.	6	9 0 0	1 10 0
Ditto	28	42 0 0	1 10 0
Ditto	54	81 0 0	1 10 0
Ditto	12	18 0 0	1 10 0
	100	150 0 0	1 10 0
Currency Lease	400	800 0 0	2 0 0
Ditto	20	40 0 0	2 0 0
Ditto	30	75 0 0	2 10 0
Ditto	8	24 0 0	3 0 0
Ditto	60	120 0 0	2 0 0
Ditto	26	61 0 0	2 6 22
Ditto	30	214 10 0	7 3 0
	574	1,334 10 0	2 6 .12

Commissioner Gill says—"These are not all the crushings that have been taken from this field, as it is well known that many were kept secret, and no records can be found, and there is abundant testimony as to the richness of the properties."

At the time of my visit all the old shafts were abandoned, and I regret that I was unable to descend any of them. They appear to have been abandoned as soon as the "mundic stone," was reached. Whether the mundic contains payable gold, and the machinery on the field was unable to extract it, I cannot say, as there was not sufficient of it at the surface for a fair sample to be taken for assay.

From Dreghorn I went to Harvest Home for the purpose of examining the Star Beds (Lower Devonian) in that district.

The country as far as Mount St. Paul—14 miles south of Dreghorn—consisted entirely of granite. I camped one night on Mount St. Paul's Creek, and ascended the mountain. Its summit is 700 feet above the bed of the creek. It is made up of a rock which has the appearance at first sight of a much decomposed porphyry. The rock in places shows beautiful fluxion structure, and in parts contortion. It is full of angular pebbles of felsite and porphyry, which are best seen on the weathered surfaces. In other places it is a mass of buff-coloured felspathic dust. It contains small veinlets of oxide of iron, and weathers a reddish colour, showing that the rock contains much iron in its composition. Near the base of the mountain, on its western side, there is a silicated porphyry, consisting of felspar showing fluxion structure with rounded blebs of quartz.

There

There is no doubt that this represents the once deep-seated "neck" of a volcano. All the materials which were ejected from the crater, and the crater itself, have long since been removed by denudation.

About 3 miles south of Mount St. Paul the road crosses the divide between St. Paul's Creek and Cattle Creek, which flows south-west into the Rolleston River—a tributary of the Cape River.

DESERT SANDSTONE.

On the divide the granite is capped with beds of Desert Sandstone, which is made up of beds of white sandstone with layers of quartz pebbles, and beds of conglomerate made up chiefly of pebbles of quartz. The Desert Sandstone forms bold cliffs which face the north, and it has gradually thinned away by denudation towards the south. It extends about 3 miles across in a north and south direction. Beyond this granite shows again in the creeks and gullies. The Desert Sandstone beds are nearly horizontal.

STAR BEDS.

Six miles south of the range, after passing over a reddish sandy soil flat, beds of a fine-grained felspathic sandstone are seen in Cattle Creek, dipping E. 10 degrees N. at 20 degrees. Portions of the sandstone contain a large amount of iron in their composition and weather red. Above this is a coarse sandstone or grit with the same dip.

I found no fossils in these beds, but they are probably Star Beds (lower carboniferous), as they have the same strike and dip as beds of that age met with at Harvest Home and Mount McConnell Stations.

Continuing southwards towards Harvest Home Station, sandy flats are crossed to within about a mile of the station, where a sandstone dips E.N.E. At Harvest Home beds of sandstone with thin beds of shale dip E.N.E. at 25 degrees. In these I discovered some not very distinct plant markings (*Calamites*?).

On the south side of the Cape River, opposite to Harvest Home Station, a high ridge occurs coming down close to the river. On the northern flanks of this ridge are similar sandstones dipping steeply E.N.E. against a felsitic rock, much resembling that of Mount St. Paul. The ridge is composed chiefly of this rock.

The country is quite flat from here across the valley of the Suttor River.

Along the road from Harvest Home Station to Lornesleigh Station, numerous outcrops of sandstones, sandy shales, and quartzites occur, having a general dip towards the east at from 22 to 30 degrees. I could find no fossil remains in them. A large reef of "buck" quartz crosses the road in a north-north-easterly direction, about 2 miles east of the station.

After crossing the Cape River at its junction with the Suttor River, near Lornesleigh Station, the road passes over alluvial flats for a distance of 4 miles. At this point beds of felspathic sandstone and sandy shales dip E. 35 degrees S. at 20 degrees. These beds are full of stems of *Lepidodendron*, *Calamites*, and *Clyclostigma* (?)—a stem with circular leaf scars. I also found the nearly perfect remains of a fish, which Mr. R. Etheridge, junr., says certainly belongs to the family *Palæoniscidæ*, and probably is of the genus *Palæoniscus* itself.

The ridges all about here consist of similar beds. About half a mile south of this spot there is a bed full of some small somewhat tripartite nodules, which I thought might be *Trigonocarpon*, but Mr. Etheridge pronounced them too badly preserved to determine.

Between this and Mount McConnell Station, *Lepidodendron* occurs in many places in the rock. At that station the beds dip south-east.

Along the road from Mount McConnell Station to Monnt Wyatt, black soil flats are traversed for about 2 miles, and then there is a small boss of granite about 2 miles across, beyond this the Star beds occur again dipping to the north-west for 5 miles in a south-east direction, and then Gympie beds come in.*

Lepidodendron also occurs in the ridges about 2 miles east of the station, on the eastern side of the Sellheim River.

Between Mount McConnell Station and Monnt McConnell itself, which is about 10 miles to the north, the beds are dipping S.E. at 40 degrees. What are known as the "Crags" are on the western side of the road, about 7 miles from the station. They are cliffs of hardened sandstone or quartzite of from 50 to 100 feet in height.

The rocks immediately south of Mount McConnell consist of beds of sandstones, fissile shales, and conglomerates, dipping to the south-east at a high angle. The pebbles of the conglomerates consist chiefly of quartz, sandstone, and quartzite. About half a mile west of the mountain, a thin bed of blue impure limestone dips south-east at 45 degees. West of the limestone again, as far as the Suttor River, thin laminated shales occur dipping south-east at 35 degrees. These shales are full of segregated nodules of from an inch to nearly a foot in diameter. I searched carefully for any fossil remains about here, but I was only successful in finding a few, which were very indistinct.

Mount McConnell itself is composed of felsite. The Star Beds occur as far as the Burdekin, and can be traced 6 miles or so down the river.

Almost immediately after crossing the Burdekin, just below its junction with the Suttor, the granite country is met with.

WILLIAM H. RANDS,
Assistant Government Geologist.

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* Report on the Sellheim Silver Mines and surrounding District by R. L. Jack. Brisbane: By authority, 1889.

APPENDIX 1.

YIELD OF GOLD OF THE CAPE RIVER GOLD FIELD SINCE THE YEAR 1878, FROM THE ANNUAL RETURNS OF THE WARDEN.

Year.	Year.
1878. 3,000 oz.	1884. 1,944 oz.
1879. Estimated at 2,000 oz.	1885. 1,000 oz.
1880. Reef gold, 442 oz.; alluvial, 615 oz.	1886. 500 oz.
1881. Estimated at 3,000 oz.	1887. Reef gold, 987 oz.; alluvial, 124 oz.
1882. Estimated at 3,000 oz.	1888. 328 oz.
1883. Reef gold, 200 oz.; alluvial, 1,000 oz.	1889. Reef gold, 643 oz.; alluvial, 1,058 oz.

These returns are only approximate.

No records appear to have been kept of the earlier years in which large yields of alluvial gold were obtained.

APPENDIX 2.

A SHORT DESCRIPTION OF SOME OF THE CAPE RIVER ROCKS EXAMINED IN THIN SECTIONS UNDER THE MICROSCOPE.

1. A dark-coloured, fine-grained *hornblende schist*, from Union Reef, near Mount Davenport. The slide consists almost entirely of green *hornblende* and quartz. The quartz contains enclosures of *apatite* and other minute enclosures. In a section cut transversely to the cleavage the longer axes of the hornblende have a linear arrangement.

2. A white *mica schist*, from Mount Davenport. The slide consists chiefly of *quartz* in small grains, with *mica*. In a section cut transversely to the cleavage of the rock the mica is arranged in layers.

3. A *hornblende schist*, from the southern slope of Mount Davenport. Green *hornblende*, beautifully cleaved, with bands consisting of grains of *quartz*. There is more hornblende than quartz in the section. *Magnetite* occurs in grains.

4. A red fine-grained *granite*, from Mount Frank. *Quartz* occupies the larger portion of the slide; it is full of minute enclosures. *Plagioclase felspar*, which is much kaolinized. White and black *mica*. The slide contains numerous large specks of *magnetite*.

7. *Felsite*, from dyke in schists, Pentland Reefs. The rock consists of a fine decomposed felspathic groundmass, with *ferrite* throughout it.

8. A red, medium-grained *granite*, from Homestead Range. The section is rather thick and indistinct. The slide contains crystals of *plagioclase felspar*, and also beautiful star-shape spherolites of plagioclase felspar; *quartz*, with enclosures of *magnetite*; *mica*; and specks of *magnetite* throughout the slide.

12. *Dolerite*, from dyke near Specimen Creek, Mount Remarkable. This slide is very thick, and the only minerals that can be determined are decomposed *felspar* and small specks of *augite* in a semi-crystalline groundmass.

15. *Graphic granite*, from dyke near Specimen Creek, Mount Remarkable. The slide consists of elongated plates of *quartz* in *felspar*. All the quartz extinguishes simultaneously; and the same is the case with the felspar.

16. *Quartzite*, from Golden Hill, near Mount Remarkable. This rock consists almost entirely of semi-rounded and irregular shaped granules of *quartz*, containing numerous enclosure, among which are small acicular crystals, probably *apatite*. There are crystals of *magnetite* in the slide, and some *ferrite*.

17. *Quartz felsite*, from a dyke on the ridge north of Mount Remarkable. The slide consists of an amorphous groundmass, with blebs of *quartz* throughout it. It contains a little ferrite.

22. *Gabbro*, a dark crystalline rock from a dyke near Specimen Creek. This slide is made up of *diallage*, which is very feebly dichroic, a *plagioclase felspar*, and *mica*. Small grains of magnetite occur throughout it.

24. A white kaolinized *felsite*, from Running Creek, Norwood. It consists of an amorphous groundmass, with minute grains of *quartz* throughout it, which have a banded structure. There are also small grains of *magnetite*, and a few porphyritic crystals of *felspar*.

25. A reddish-brown *felsite*, from Running Creek, Norwood. The slide shows a fine felspathic groundmass, with minute lath-shaped crystals of felspar throughout it. Porphyritic crystals of *plagioclase felspar*, with enclosures of *apatite* and *magnetite*; a few porphyritic crystals of *orthoclase felspar*. Crystals of *magnetite* occur in the groundmass. *Ferrite* occurs in considerable quantity, giving the red colour to the rock. The rock shows a beautiful perlitic structure.

26. A purplish *felsite* or *porphyry*, from Running Creek, Norwood. The rock consists of a dark-coloured amorphous groundmass, containing a large amount of *ferrite*, and showing in parts a well-marked fluxion structure. There are numerous porphyritic crystals of decomposed *felspar*, most of which were rubbed away in the preparation of the slide. Large crystals of *magnetite* occur.

27. *Dolerite*, from a dyke in Chinaman's Gully, Sandy Creek. A dark, fine-grained rock with a spherolitic structure on weathering. A felspathic groundmass full of small lath-shaped crystals of *felspar*, and also *magnetite* in both large and small grains. The pyroxene element has been changed into *viridite*. There are a few larger crystals of both *orthoclase* and *plagioclase felspar*.

30. *Hornblende schist*, from Sandy Creek. A very beautiful slide containing green *hornblende*, having a linear arrangement, and showing very perfect cleavage parallel to the plane of symmetry and faces of the prism. These crystals contain enclosures of *apatite* and *epidote*. Beautifully twinned crystals of *plagioclase felspar*, some of which appear to have had a secondary growth; they contain enclosures of *apatite*. A few solitary crysals of *orthoclase felspar*. There are a few specks of *quartz*; *magnetite* is very rare.

31. *Garnetiferous granite*, from the Pentland Range, at the head of Sandy Creek. The slide is much broken. The minerals that can be distinguished are:—*Quartz*, containing prismatic enclosures of *apatite*; *plagioclase felspar*; *mica*, and *garnets*.

33. *Hypersthene rock*. A dark-coloured, highly crystallised rock, from a dyke on Daunton's Hill, Upper Cape. *Hypersthene* is the principal mineral. It is a green mineral, possessing strong pleochroism; the cleavage is prismatic. The mineral extinguishes parallel to the planes of cleavage. It contains several hexagonal enclosures of *apatite*, and also of *quartz*; streaks of *quartz* follow the cleavage planes. It also contains enclosures of *magnetite*. *Quartz* in large plates is the next mineral in importance; it is full of very minute enclosures. *Brown mica* occurs in the hypersthene, and also in a semi-transparent iron compound—*leucoxene*, of which mineral there is a large amount in the slice.

34. *Hornblende schist*, from Daunton's Hill, Upper Cape. A crystalline rock resembling a coarse diorite, except that the hornblende occurs more or less in layers. This is the rock in contact with which the leaders on Daunton's Hill ceased to carry gold. The rock is made up to a large extent of very beautifully twinned crystals of

of *oligoclase felspar*, full of small hexagonal enclosures of *apatite*, and also enclosures of *leucoxene*. *Hornblende*, well-cleaved, and containing also enclosures of *apatite*. *Quartz* in small blebs. *Magnetite* changing around its edges into *leucoxene*.

35. *A highly crystalline schist*, from Mount Elvan, Upper Cape. *Quartz* is the principal mineral; it contains enclosures of small *garnets*. Entwined around the quartz is green *hornblende*. *Plagioclase felspar*. Very small *garnets* occur throughout the rock.

36. A fine-grained, grey *micaceous granite*, from Mount Elvan, Upper Cape. The minerals in the slide are :— *Plagioclase felspar*, some of which is much decomposed. Well-cleaved *white mica*; and *quartz* with acicular crystals of *apatite*, and other minute enclosures.

38. *A purplish porphyry*, from the Cape River, near the Pot-Hole Lead, Upper Cape. It consists of an amorphous groundmass, showing fluxion structure, and full of *ferrite* and *magnetite*. It contains porphyritic crystals of *plagioclase felspar*.

40. *Olivine basalt*, from Mount Black. A compact black rock, possessing polarity. The slide shows a micro-crystalline groundmass, containing numerous specks of *magnetite*, with crystals of *olivine*, a few crystals of *felspar*, and specks of *augite*.

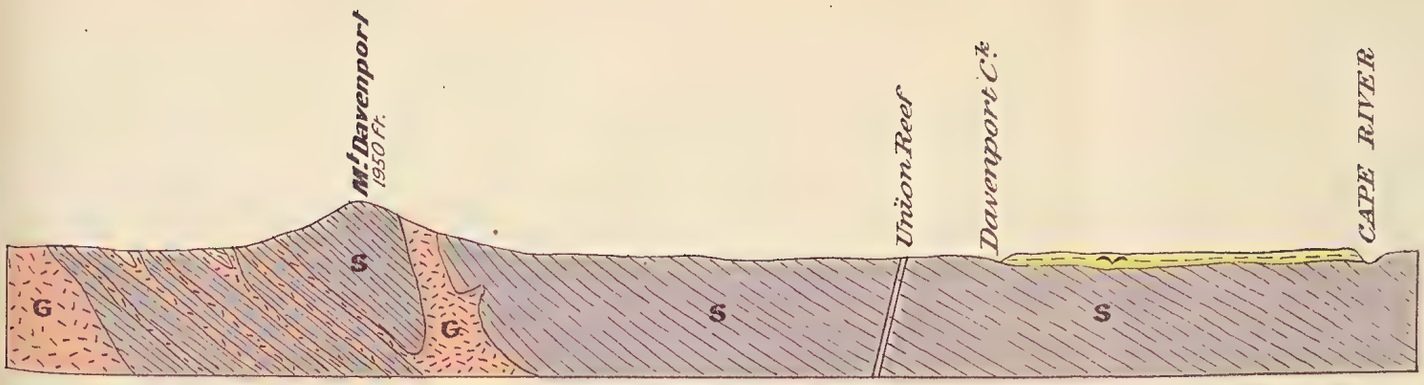
42. *Olivine basalt*, from the Tableland, Oxley Creek, a somewhat scoriaceous basalt containing zeolites. The rock consists of an interlaced mass of acicular crystals of felspar, with crystals of *olivine* throughout it. Some of the olivine crystals are much decomposed around their margins, and along cracks in the crystals. *Magnetite* is comparatively rare.

43. *Basalt*, from the basaltic wall, Lolworth. A highly scoriaceous basalt. The rock was a difficult one to cut, and the slice is very small. It shows an interlaced mass of crystals of *plagioclase felspar*, with small specks of *olivine*.

Note.—The microscopical slides described above were prepared for me by Mr. A. W. Clarke, of Messrs. Coane and Clarke, Charters Towers.

Price 1*s*. 6*d*.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.



Alluvial Deposit ~ Granite G Schists S

Fig 1. Section across Mt. Davenport and the Cape River.

Horizontal and Vertical Scale 200 ft. to an Inch.

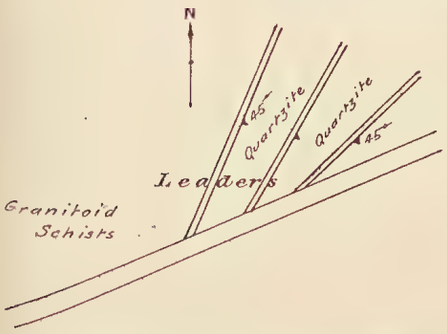
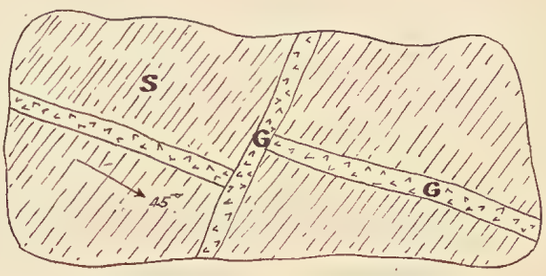


Fig. 2. Plan showing position of Reef and Leaders at Calland's Claim, Golden Hill.

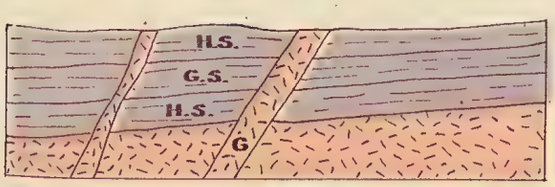


S. Schists. G. Granite.

Fig. 3. Plan. Faulting of one Granite Dyke by another (Chinamans Gully)

S. Schists S G Granite G

Fig. 4. Section showing contortion of Schists in the neighbourhood of Granite Dykes. (Chinamans Gully)



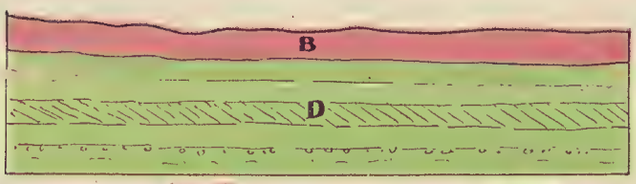
Hornblende Schists H.S. Granite G

Granitoid Schists G.S.

Fig. 5. Section (Sandy Creek)

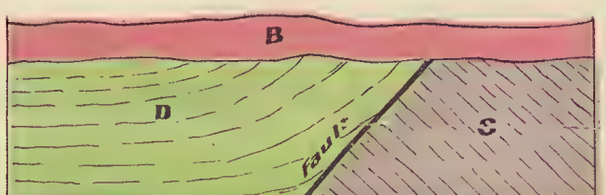
Alluvium ~ Desert Sandstone D

Fig. 6. Section across Belt's Creek



Basalt B Desert Sa. D

Fig. 7. Section Walkers Creek



Basalt B Desert Sandstone D Schists S

Fig. 8. Section across Fault (Walker's Ck.)

Govt. Litho. Office, Brisbane Q.

Plan N°1.

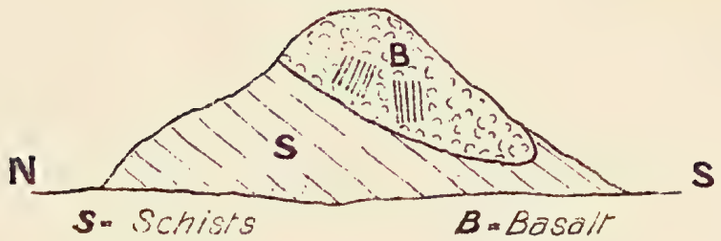
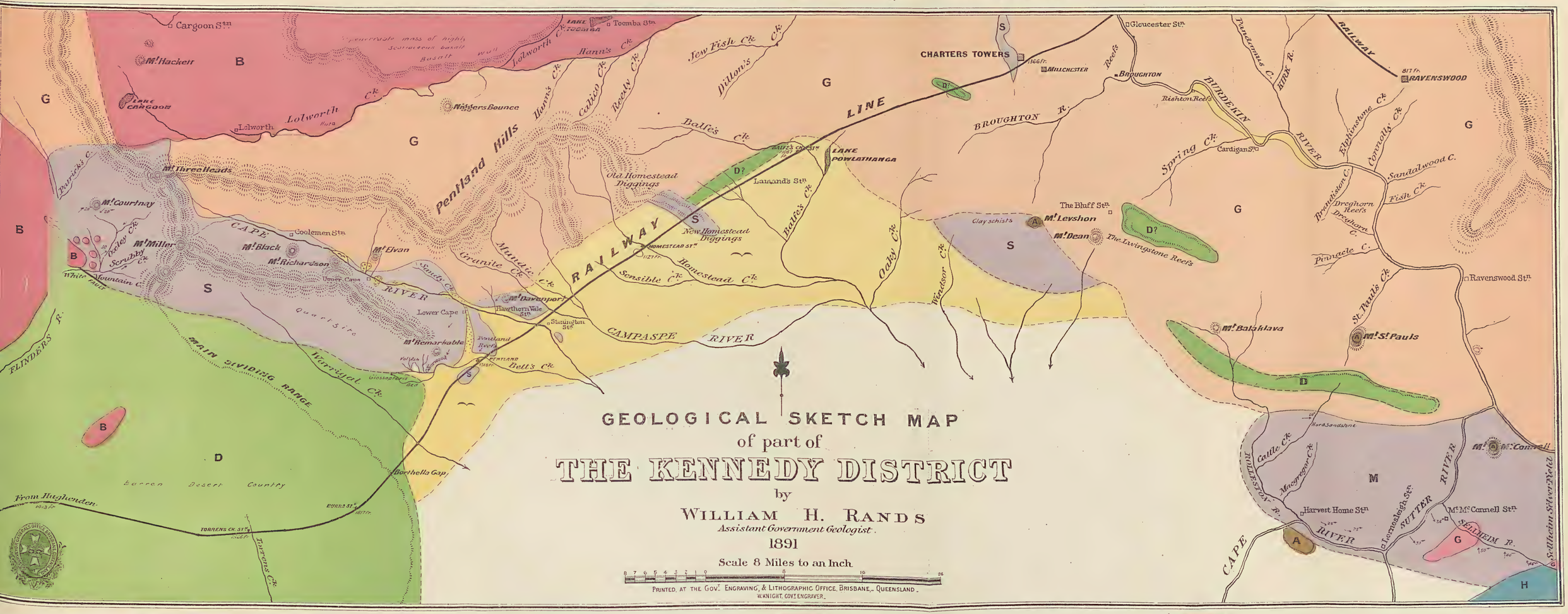


Diagram shewing Mount Black, capped with Basalt.

GEOLOGICAL SURVEY OF QUEENSLAND



GEOLOGICAL SKETCH MAP
of part of
THE KENNEDY DISTRICT
by
WILLIAM H. RANDS
Assistant Government Geologist.
1891

Scale 8 Miles to an Inch

PRINTED AT THE GOVT ENGRAVING & LITHOGRAPHIC OFFICE, BRISBANE, QUEENSLAND.
W. KNIGHT, GOVT ENGRAVER.

Recent Alluvium ~ | *Alluvial Leads* (Post Tertiary?) | *Basalt* (Tertiary) B | *Desert Sandstone* (Upper Cretaceous) D | *Granite* (Age undetermined) G

Gympie Beds (Carboniferous Permian) H | *Star Beds* (Lower Carboniferous) M | *Schists* (Age undetermined) S | *Volcanic Ash & Agglomerates* A | *Dip of Strata* ↘

23 NOV. 1933

74

1891.

QUEENSLAND.

BROKEN HILL.

(NOTES ON, BY ROBERT L. JACK, GOVERNMENT GEOLOGIST, QUEENSLAND.)

Presented to both Houses of Parliament by Command.

In returning from the meeting of the Australasian Association for the Advancement of Science, held at Christchurch, I visited Broken Hill by the desire of the Honourable the Minister for Mines.

Broken Hill is situated about 20 miles east of the western boundary of New South Wales, about midway between Victoria and Queensland. As it is not located on any but the most recent maps it may be set down as approximately in latitude 31° 52′ S., and longitude 141° 20′ E.

Although situated in the Albert district, in the Colony of New South Wales, the fact that Broken Hill is 590 miles as the crow flies from Sydney, while it is only 257 from Adelaide and 230 from Port Pirie, is sufficient to direct the bulk of the traffic to the ports of South Australia, with which it has been connected by rail since 1887. The distances by rail are—From Port Pirie 253, and from Adelaide 334 miles, the portion of the line within New South Wales, 36 miles in length, being owned by the Silverton Tramway Company. Hay and Bourke, the present termini of the two western trunk lines from Sydney, are respectively 270 and 300 miles from Broken Hill; so that, adding these distances to the length of the already constructed lines, the total lengths of railway required to connect Broken Hill with Sydney would be at least 724 and 803 miles respectively. To connect Broken Hill with Nyngan, on the Bourke line, *viâ* Cobar and Wilcannia, would require at least 350 miles of railway, in addition to the 377 already constructed between Sydney and Nyngan—in all 727 miles. In view of these figures it is easy to see that the New South Wales ports can never compete with the South Australian in offering shipping facilities to the products of Broken Hill, although the passenger traffic from Sydney would be secured by a direct railway. I observe from newspaper reports of the evidence taken by a Royal Commission that official and other witnesses for the most part take this view, although some contend that the extension of the New South Wales railway system to Broken Hill would aid in opening up the country.

I travelled to Broken Hill, as most people do, from Adelaide. The railway time-table is so arranged that the greater part of the journey is performed in the dark, but day breaks as the train crosses (at Cockburn) the dividing line between South Australia and New South Wales. Through the small hours we had traversed what appeared to be a dreary, sandy country, almost flat. It is so at least in a season of drought such as that which prevailed at the date of my visit, although I believe it is reckoned fair pastoral country in good seasons. The altitude of Cockburn is given in the official railway time-table as 691 feet above the sea level. Broken Hill is said to be about 400 feet higher. Between Cockburn and Broken Hill the soil is poor and sandy, and the country is generally low, but diversified by a few slight elevations, among which the mining districts of Umberumberka and Silverton are situated.

The town of Willyama (the official name of Broken Hill), founded in 1883, had an estimated population of 3,000 in 1886,* of 5,000 to 6,000 in 1887,† and of 23,000 in 1891. Substantial brick, stone, and concrete edifices are rapidly replacing the original structures of wood and iron. The town has already, although less than eight years old, a municipal council, railways, omnibuses, cabs, brass bands, gas, electric lights, telegraphs, telephones, first-class hotels, and in fact all the latest triumphs of civilization except "water laid on."

The following history of the discovery of Broken Hill, by Mr. Warden Brown, is taken from the Annual Report of the Department of Mines, New South Wales, for 1886:—

"In September, 1883, one Charles Rasp, who was then a boundary rider on Mount Gibbs Station, marked out an area of 40 acres, believing the enormous outcrop of manganese to be tin. On reaching the station at night he informed Mr. McCulloch, the general manager of the station, also his mates, of what he had done, when it was then and there determined to form a small syndicate, consisting of seven persons, all station hands, each putting £70 into the venture. The first thing done was to apply for a mineral lease of the land taken up by Rasp, together with six other 40-acre blocks on the same line. These seven blocks now constitute the Broken Hill proper, and were originally applied for by the following persons:—George McCulloch, George Urquhart, Charles Rasp, James Poole, Philip Charley, David James, and George M. Lind. Work was soon commenced, and assays made for tin, but, I need hardly say, with no beneficial result. It was then decided to sink a shaft and prospect for silver, which by this time had been proved

* Mr. Warden Brown in Annual Report of the Department of Mines, New South Wales, for 1886.
† *Ibid*, for 1887.

proved to exist in the district. The country being hard, and the sinking not showing very encouraging prospects, coupled with the fact that the small amount of capital that had been subscribed was exhausted, caused some of the original shareholders to sell to others, Lind being the first to retire, his interest being taken by McCulloch and Rasp, Urquhart being the next to give in. It was now determined to increase the syndicate to fourteen for the purpose of raising more funds for further prospecting. This arrangement was carried out, and the work continued until the latter part of 1884, when chlorides were first found in Rasp's shaft at a depth of about 100 feet. Shortly after rich chloride ore was found in the cap of the lode at a different part of the mine I may here state that the cap of this lode is discernible through the seven blocks owned by the company, being about 1¾ miles in length, and rising in places fully 50 feet above the surface, while in the workings below it has proved in places to be considerably over 100 feet wide. About the middle of the year 1885 it was determined by the then proprietors to offer a portion of this enormous property to the public, and on the 10th August, 1885, the present Broken Hill Proprietary Company was floated. The prospectus issued was to form a company of 16,000 shares, of £20 per share, the fourteen shareholders receiving 1,000 shares each, paid up to £19; the remaining 2,000 were offered to the public at £9 per share paid on allotment, and then to be considered paid up to £19, after which all shares alike were liable to a call of 20s. on formation of this company. £3,000 was to be paid (in addition to the shares) to the original proprietors for expenses previously incurred. Thus it will be seen that on the formation of the present company only £15,000 was available for all purposes. Extensive operations were now commenced, machinery erected, and the first two smelters put in blast in May last, and the result so far, I think, may be considered satisfactory. Up to date £64,000 has been paid in dividends, and another of £1 per share is payable on the 19th January, 1887. Machinery and supplies of coke, firewood, explosives, &c., now on the mine exceed in value several thousands of pounds; substantial stone buildings have been erected for manager's residence, offices, and other purposes. All this has been paid for by the value of ore won from the mine whilst sinking shafts and driving levels, which, in ordinary cases, would be considered dead work. The supply of ore is apparently unlimited. The market value of the mine is now £1,520,000, the latest quotations being £95 per share, and few sellers at that figure. In June and July of 1884 a one-fourteenth in this property was worth about £100, some shares being sold for less than that amount."

A paragraph on the "discovery of the mine" appended to the report of the directors of the Proprietary Company for the half-year ending 30th November, 1886, contains the following:—

"The interest in the seven blocks was amalgamated into one private company or syndicate under the name of 'The Broken Hill Mining Company,' the members of which were as follows, holding shares in equal proportions:—Philip Charley, George Urquhart, G.A.M. Lind, David James, James Poole, Charles Rasp, and George McCulloch. After a little surface prospecting had been done, exposing large bodies of comparatively lower grade carbonate of lead ore, and not knowing, and not happening to have tested, the richer iron and kaolin surface ores, Lind retired from the company. . . . . Towards the end of 1884 the existence of chlorides was first noticed in Rasp's shaft. This gave an impetus to prospecting, and chlorides were shortly afterwards found and noticed on the surface in the iron ore by Thomas Low, who at the time purchased by private arrangement one-half of a fourteenth share. The rich surface kaolin ore was accidentally dropped across by 'Harry,' an aboriginal in the employ of Mr. Jamieson, who had taken the management of the property."

Without following the progressive development of the company in its details, it is enough to say that it originally held Blocks 10, 11, 12, 13, 14, 15, and 16, comprising in all 297 acres 1 rood. In 1887 Block 14 (40 acres) was sold to the Broken Hill Proprietary Block 14 Company, Limited. In 1888 Blocks 15 and 16 (101 acres 3 roods) were sold to the British Broken Hill Proprietary Company, Limited, and Block 10 (35 acres 2 roods) to the Broken Hill Proprietary Block 10 Company, Limited, thus leaving the parent company in possession of Blocks 11, 12 and 13 (120 acres), in addition to sites for water supply, &c. The following summary of dividends and bonuses paid, and additional shares allotted to shareholders since the formation of the Broken Hill Proprietary Company is taken from the directors' report for the half-year ending 30th November, 1890:—

Total amount of dividends paid	£2,152,000
Total amount of bonuses paid	592,000
Total	2,744,000
Nominal value of shares received from the Broken Hill Proprietary Block 14 Company, Limited	432,000
Nominal value of shares received from the British Broken Hill Proprietary Company, Limited	400,000
Nominal value of shares received from the Broken Hill Proprietary Block 10 Company, Limited	912,000
Grand total	£4,488,000

A plan on the scale of 40 chains to the inch, published by Messrs. Sands and McDougall, of Melbourne, shows the areas occupied by the companies already mentioned and others which have taken up ground in the vicinity. This plan, as well as the half-yearly reports of the directors, should be in the hands of readers of this report.

The following notes were made during the week commencing 15th March of the present year. I could not hope, in the time at my disposal, to do more than make a selection from among the most important of the mining properties. It is needless to say that a thorough inspection of all the mines would occupy several months, while the Proprietary Mine alone would demand at least a fortnight.

The main line of the Broken Hill reef runs north-east and south-west (magnetic), but the cap of the lode does not follow a straight line. From north to south (I say "north" and "south" instead of "north-east" and "south-west" for the sake of convenience) the line of the lode, for a distance of three miles, is held by the Broken Hill North, British Broken Hill Proprietary, Block 14 Proprietary, Broken Hill Proprietary, Block 10 Proprietary, Central, and South Companies. The cap of the lode rises above the surrounding country to a level varying up to 80 or 100 feet.

BROKEN HILL PROPRIETARY COMPANY.

Descending by Wilson's shaft, which is situated in Block 13, about 200 feet south of its junction with Block 14, I landed at the 212-feet level (216-feet level of McCulloch's shaft). Between Wilson's shaft and Block 14 the lode is about 170 feet in width, and consists mainly of blackened carbonate of lead associated with iron and manganese oxides, with small white crystals of cerussite, scattered, as it were, porphyritically, through the crumbling mass. Solid black carbonate ore extends to the boundary of Block 14. The schists, quartzites, &c., of the country rock dip west-north-west, while the lode underlies to the north-west at a steeper angle. At the north boundary of Block 13, 125 feet beneath the cap, the lode, according to the manager's report, was 135 feet wide. The 212-feet level from Wilson's shaft southward for about 120 feet to beyond Rasp's shaft is to the west of the lode, which has been stoped out. In Rasp's shaft, according to the manager's report, the lode was 14 feet wide at the depth of 100 feet, 27 feet wide at 150 feet, and 18 feet wide at 212 feet. On the 212-feet level for 222 feet north of the shaft the lode averaged 25 to 28 feet. In the south drive at the same level the lode was 45 feet wide. The lode was 34 feet wide in a crosscut from Rasp's shaft at the depth of 278 feet. From Rasp's shaft to Patterson's shaft (about 1,250 feet) the lode, where it can be seen, consists of carbonate of lead carrying chloride of silver, but for the greater part of the distance it has been stoped out.

At McCulloch shaft, 400 feet south of Rasp's shaft, the manager reported the lode 108 feet wide at the 216-feet level, and 30 feet wide at the 316-feet level. In No. 2 tunnel (in Block 12, about 200 feet north of Patterson's shaft), 90 feet above the 212-feet level, and 192 feet beneath the cap of the lode, according to the manager's report, the lode was 60 feet wide.

At Patterson's shaft the 212-feet level ends, and I descended about 28 feet to what is called the 208-feet level, as measured at Jamieson's shaft. Where Patterson's shaft meets the level, the lode consists of solid lead carbonates, showing spots of chloride of silver. The carbonate ore continues for about 300 feet to near Brodribb's shaft, where a little kaolin ore is first seen. At Brodribb's shaft, at the 66-feet level (reckoned from Jamieson's shaft), the manager reported the lode 60 feet wide, and at the 132-feet level 66 feet wide. From Brodribb's to Jamieson's shaft the level is timbered, but carbonate of lead can be seen at intervals, and has evidently been solid for the greater part of the distance. At Jamieson's shaft the manager reported the lode 78 feet wide at the 76-feet level, and over 43 feet at the 142-feet level. From Jamieson's southward to Knox shaft, about 200 feet, the ground has been stoped up for about 150 feet. The ore body here was reported by the manager to average 90 to 103 feet wide. It appears to have consisted mainly of kaolin and siliceous iron ores with quartz. At the 76-feet level the lode was 66 feet wide in the north level, and 100 feet wide in the south level. The manager reported the lode in Knox shaft to be 92 feet wide at the 132-feet level (76-feet level of Jamieson's), and 60 feet wide at the 155-feet level.

Southward from the stopes above the 208-feet level no ground has been stoped out for a distance of 500 or 600 feet. The level shows principally kaolin ore mixed up with country rock Probably the lode itself is to right or left of the level. The last 200 or 300 feet of the level towards McBryde's shaft shows large bodies of kaolin ores rich in chloride of silver. McBryde's shaft is 780 feet south of Knox's shaft. Beyond McBryde's shaft, for some distance, the level shows kaolin ore, which is said to be of low grade. About 150 feet south of McBride's shaft, siliceous iron ores begin to be met with in the level. A little further south, carbonate of lead begins to be visible in the iron ore. From this point for about 400 feet to the boundary of Block 10 there is a body of ore which can hardly be spoken of in temperate language. Attaining a thickness in places of 230 feet, this ore varies very much in character. Sometimes it is a siliceous ironstone containing carbonate of lead and showing numerous cavities lined with stalactites of ironstone. Sometimes there are immense solid bodies of carbonate of lead. In some places galena and zincblende are met with, but the bulk of the ore is rich lead carbonate.

The manager's report for the half-year ending 30th November, 1890, says that "the great bulk of the ore in the extensive block of ground from Brodribb's shaft to Block 14 boundary—a distance of nearly 1,900 feet—is of a character low in silver and high in lead, whilst in that portion of the mine at the other end from Brodribb's shaft to the Block 10 boundary, the ore is generally of a dry siliceous nature, high in silver and low in lead. By means of a careful blending of the ores from the different localities in the property we are enabled to make a mixture for our furnaces which smelts readily and at a low cost per ton."

I did not visit the workings below the 212-feet (or 216 feet of McCulloch's shaft) level, and 208 feet (Jamieson's) level. 316 feet (McCulloch's) level has been carried from 40 feet north of Wilson's shaft for 650 feet to the south—*i.e.*, about 100 feet south of McCulloch's shaft. The same level has been carried south from 50 feet north of Patterson's shaft for a total distance of 2,400 feet to the boundary of Block 10. McCulloch's shaft has been sunk 170 feet below the 212-feet level. Patterson's shaft has been sunk 160 feet, Jamieson's shaft 225 feet, McBryde's shaft 130 feet, and McGregor's shaft 80 feet, below the 208-feet (Jamieson's) level.

From transverse sections issued with the manager's reports, the underlie of the lode, so far as the workings show, appears to be as follows:—

At Rasp's shaft, 17 degrees to the west down to 278-feet level.
At No. 1 Air shaft, 140 feet south of Rasp's shaft, practically vertical, underlying a little to the east near surface, and a little to the west at the 212-feet level.
At McCulloch's shaft, 80 degrees to the west down to 216-feet level, and about 60 degrees to east from 216 to 316-feet level.
At Brodribb's shaft, slight underlie west.
At Jamieson's shaft, nearly vertical in lower levels, although underlying slightly to west near surface.
At Knox's shaft, vertical.
At McBride's shaft, 80 degrees to west.
At McGregor's shaft, 70 degrees to west.

The company has now thirteen smelting furnaces at work. From a table in last half-year's report of the directors it appears that for the six months ending 30th November, 1890, 91,923 tons of ore were treated, with a result of 3,697,196 oz. of fine silver (= 40·2 oz. per ton), and 14,939 tons (= 16·2 per cent.)

cent.) of lead. From the opening of the mine in 1886 to 30th November, 1890, 483,078 tons of ore were treated, with a result of 20,594,272 oz. of fine silver (= 42·6 oz. per ton), and 83,414 tons (= equal 17·2 per cent.) of lead. It may be mentioned that the Comstock lode in Nevada, at its best, in 1877, produced, according to official returns, $14,520,614 silver, besides $21,780,922 gold; but the product had fallen in 1887 to $2,030,053 silver, and $2,481,176 gold.

BRITISH BROKEN HILL.

This company, as has already been mentioned, holds Blocks 15 and 16, which formerly belonged to the Broken Hill Proprietary Company, and which comprise 101 acres 3 roods.

Descending by No. 1 shaft for 100 feet the lode is reached in 20 feet by a crosscut to the west. The lode having been cut, levels are driven on it to north and south. North of the crosscut the level, as far as the stopes, shows patches of carbonate of lead among soft black manganese and iron oxide. The southern face of the first floor of the stopes shows carbonate of lead with a little manganese and iron oxide. The northern face of the same floor shows the lode to be four sets wide—*i.e.*, 24 feet. The ore consists of solid lead carbonate with manganese and iron oxides and heavy white lead carbonate scattered through manganese and iron oxides. This is near No. 2 shaft, about 180 feet north of No. 1. In the level between the stopes and No. 2 shaft the carbonate ore is at least three sets (18 feet) wide.

At the 200-feet level the lode is reached by a crosscut 53 feet west of No. 1 shaft. The underlie of the lode may be calculated, from the data afforded by the cap and the crosscuts at 100 and 200 feet, to be about 76 degrees to the west. North of the crosscut the 200-feet level passes first through galena (poor in silver) mixed with garnets and zincblende. I was informed that this ore contains on an average 25 per cent. of zinc, 25 per cent. of lead, 14 per cent. of iron, and 15 per cent. of silica. This ore is replaced to the north by carbonate of lead, at least on the hanging wall. In the stopes above this portion of the level the first floor shows honeycombed carbonate of lead with iron stains, but comparatively little manganese. On the second floor of the stope similar ore is seen, mixed with a little kaolin ore. The ore stoped out above this level is evidently the same body which is being stoped out above the 100-feet level.

The crosscut west from the No. 1 shaft to the lode shows sulphide ores mixed with country rock. It is continued for 30 feet beyond the lode through a hard siliceous rock charged with sulphides, chiefly of zinc, and garnets.

According to Mr. Blakemore, who guided me through the mine, the carbonate ore is richer in silver when there is more iron oxide and less manganese oxide. Carbonate of lead, when white and unaccompanied by manganese or iron oxides, is generally poor in silver. As a rule the ore is richer in silver where there is but little lead.

In the 200-feet level, south of No. 1 shaft, a terrible disaster has occurred, with the effect of preventing, or at least postponing, the successful working of the mine. Stoping had been carried up from the level for about 30 feet on an immense body of soft ore. The timber proved insufficient to support the superincumbent mass, and a subsidence took place, the whole mass of the lode settling down gradually on the level, leaving a cavern which extends to within 30 feet of the surface. Fortunately no lives have been lost, but the recovery of the lost workings and the winning of the ore will be a tedious and anxious operation, demanding the utmost skill on the part of the manager. Along the south level, which has been re-opened, galena and zincblende are seen between No. 1 shaft and the commencement of the subsidence. The subsidence extends for 200 feet, with the exception of a small portion where there was hard rock and no ore. The 200-feet level now re-opened, below the subsided portions, shows soft carbonate of lead ore. At the seventh floor (about 50 feet above the level) of the reclamation workings, rich carbonate of lead is seen mixed with carbonate of copper.

It is easy to understand how the subsidence took place, there being no cohesion between the friable carbonates and the hard cap and walls of the lode.

In the re-opened 100-feet level the subsidence has extended for about 200 feet from a point 100 feet south of the shaft. The ore is friable carbonate of lead in a sort of matrix of soft manganese and iron oxides. The ore in the portion which has subsided is said to have averaged 23 oz. of silver to the ton.

South of No. 1 shaft a black hard siliceous rock (streak black), forming a portion of the cap of the lode, is being quarried for flux. It contains on an average 27 per cent. of manganese, 22 per cent. of lead, and 3 per cent. of iron.

From the directors' report for the half-year ending 30th June, 1890, it appears that during that period 16,920 tons of ore had been treated, the bullion yielding 18·28 oz. of silver per ton, and 18·93 per cent. of lead. A profit of £3,843 2s. 1d. was made for the year ending 30th June, 1890. It is obvious that, but for the disaster already alluded to, the mine would have been paying handsome dividends.

CENTRAL BROKEN HILL COMPANY.

This company's workings lie south of the Proprietary Company's, an angle of Block 10 intervening.

Guided by Mr. Wm. Nicholas, underground manager, I descended by the "Central" shaft to the 400-feet level. Commencing from about 100 feet from the shaft, the north level is in "sulphide ore" (zincblende predominating), said to average 30 per cent. of lead and 23 oz. of silver per ton. Small bodies of carbonate and oxide ores are mixed with the sulphide. Near the beginning of the north level some coarse-grained galena is seen among schists. From that point much "sulphide ore" is mixed with the schist as far as a point about 400 feet from the beginning of the level, where oxidised ores "ride" on the sulphide ores. All these oxidised earthy ores are said to be argentiferous in a payable degree. Beyond this point "sulphide ores" are again met with, rich in lead but poor in silver. About 600 feet from the beginning of the level oxidised ores are again met with. They continue for about 100 feet to the face. These oxidised ores contain a good deal of visible native silver, and are said to average 68 oz. of silver per ton. "Sulphide ores" are seen mixed with rich oxides in the face. In a stope 10 feet above the level, near the face, are good carbonates of lead.

Along

Along this south level "sulphide ores" are seen for some distance, and are succeeded by country rock. The level being deflected to the east, "sulphide ores" are again met with. A fine shoot of coarse-grained galena comes down into the level near the shaft.

Having ascended by the shaft to the 350-feet level, I went south by the drive for 170 feet to its intersection by the shaft (in the Central Company's ground) common to the Central and South Companies. This drive shows both "sulphide ore" and country rock. The ground has been stoped up for some distance above the level north of the "common" shaft. The second floor of the stope shows galena and zincblende. The third floor, at the south boundary of the Central, shows "dry ore" with a little carbonate of lead. The fourth floor also shows "dry ore," gossany, and mixed with kaolin, with stalactites of brown hæmatite. These stalactites often carry native silver. The sample taken from the workings on the day of my first visit was said to have assayed at the rate of 500 oz. of silver per ton.

In the level driven north of the central shaft, stoping commences 30 feet from the shaft. The first floor shows quartz and "mullack" at the south end, and carbonate of lead at the north end. The second floor shows a solid mass of carbonate of lead, frequently crystalline, containing 50 per cent. of lead.

At the 300-feet level a crosscut is driven 200 feet west of the shaft, intersecting, at 70 feet, the main lode which is worked on the 400-feet level. Some very rich ore, containing iodide of silver, goes down from this crosscut. It is said to have yielded 1,000 oz. of silver per ton.

In the level running south from the crosscut (about 100 feet from the latter) I saw the top of the stopes which have been carried up from the 350-feet level. Here "dry ore" goes up above the level. Beyond this point, in the level, the lode thins and splits up. One hundred and seventy feet along the level a crosscut to the west connects with the "common" shaft. This crosscut intersects low-grade oxidised ores.

A drive is carried north of the "common" shaft. In about 30 feet a "rise" opens on a large body of low-grade "sulphide ore"—a mixture of kernels of sulphides of lead and zinc (the latter predominating), with garnetiferous sandstone. The same drive is carried back (south) from the "common" shaft to the company's boundary, and the lode has been stoped out above this portion of the drive to a height of nine sets.

Along the north level from the central shaft the western or hanging wall of the lode crosses the level about 70 feet from the shaft, but the lode shortly resumes its course. This part of the lode is composed of ferruginous gossan. One hundred and sixty feet from the shaft the oxidised ores end, so far as the level is concerned, running up overhead to the north, their place in the level being taken by "sulphide ores," which, however, continue for only a short distance, the remainder of the level, as far as 250 feet from the shaft, being in clean hard country rock with a little "sulphide ore."

Two hundred and fifty feet from the shaft a crosscut is driven west through country rock for 150 feet, when lode matter is cut about 15 feet wide and underlying to the west. This lode, which is to be opened up, shows quartz and carbonates and oxides of copper.

Continuing along the north level, the portion extending from 250 feet to 375 feet (from shaft) passes chiefly through clean hard country rock, but with some lode matter, mainly sulphides. Oxidised ores extend in the level from 375 feet to 500 feet (from shaft). At 375 and 500 feet respectively, winzes are carried down to the 400-feet level on the oxidised ore. The ore, especially in the 500-feet winze, is rich in native silver. Similar oxidised ores extend north along the level to 600 feet (from shaft), the eastern or footwall of the lode being occasionally seen on the east side of the level. From 600 feet to 750 feet (from shaft) there are seen, especially on the west side of the level, ferruginous oxide ores mixed with country rock. From 820 feet to 880 feet (from shaft), where the boundary of No. 10 Block is met with, the lode has been stoped up above the level.

Returning by the level to a point 600 feet from the shaft, I followed a crosscut to the west for 60 feet. There are workings to the north of the crosscut at this point on good gossany oxide ore, with some carbonate of lead, and rich in visible native silver. Again, from a short crosscut west of the level at 760 feet (from shaft), a winze is sunk on oxide and carbonate ores, and is connected with the stopes above the 350 feet north level.

Ascending by the central shaft to the 200 feet level, the level is carried, on the main or eastern lode, for 860 feet from the shaft, through gossany ores of low grade, and for 200 feet further through country rock to the north shaft. The north shaft is close to the south-eastern corner of the Broken Hill proprietary and north-eastern corner of No. 10 Block.

From the central shaft a crosscut is driven west for 100 feet to the parallel or western lode. This lode is three sets, or about 18 feet wide. It is worked down to the south on the top of a body of sulphide ore, and stoped up for two floors. Chloride of silver can be seen in the top of the stopes. After following this western lode by the level to the south for about 150 feet, I passed westward by a short crosscut, and found that beneath this crosscut the lode has been stoped out (to a width of 20 feet) for 100 feet, on lead carbonate ore, and above the crosscut for about 30 feet.

Returning to the central shaft, I found that at 250 feet along the north level on the main lode a crosscut was driven to intersect the western lode. After following the latter on the level to the north for 100 feet, a crosscut to the east shows the western lode to be at least 42 feet wide (oxide ores).

SOUTH BROKEN HILL.

Guided by Mr. Gluys, underground manager, I descended to the 300-feet level by the central shaft, for the use of which the South Company has made some arrangement with the proprietors. The South Company's boundary is 80 feet south of the shaft. At the dividing line a solid face of "sulphide ore" has been left. The footwall of the lode can be seen here, underlying to the west at a high angle. The 300-feet level is driven for 408 feet southward through the South Company's ground, and intersected by crosscuts at intervals of 50 feet.

No. 1 crosscut is 100 feet from the northern boundary. Fifteen feet east of the level it ends on the footwall of the lode. Thirty feet west the face shows a body of "sulphide ore," but the hanging wall has not been reached.

No. 2 crosscut reaches the footwall 25 feet east of the level. It is carried for 78 feet to the west. In the western arm the last 12 feet are in gneissose schist. Galena is seen in large masses near the face in several places. Native silver is visible in a rise near No. 2 crosscut.

No. 3 crosscut is carried 35 feet east to the footwall of the lode, showing for the whole distance gossany, kaolinic, and quartzose lode matter. The country rock below the footwall is clay slate. The western arm is driven for 50 feet through lode matter similar to that in the eastern, but rather more cupreous for the first half, and through gneissic country rock for the second half.

No. 4 crosscut, to the east, is 42 feet in length, for the first half in gneissic country rock. At the face it touches the footwall of the lode, on which lie about 4 feet of argentiferous cerussite, blackened by a coating of sulphate of copper.

In the level between No. 4 and No. 5 crosscuts is a mass of kaolin and mica rock, with crystals, up to 2 inches long, of biotite and blotches of iron glance.

No. 5 crosscut is carried 50 feet to the east, most of the distance through lode matter, in which kaolin and copper and manganese oxides prevail.

In the level a few feet beyond No. 5 crosscut zincblende appears in great masses on the western side. Near No. 6 crosscut are some veins of argentiferous black copper oxide. No. 6 crosscut is driven 54 feet to the east to the footwall of the lode. On the footwall there lies a vein of "sulphide ore," consisting of zincblende and galena, about 5 feet wide. This vein is said to give from 10 to 40 per cent. of lead, and from 6 to 20 oz. of silver per ton. Some portions of it are pure galena. West of this vein a "horse" of country rock occupies the crosscut as far as a winze, where some carbonate of lead has been followed down. Between the "horse" and the level the crosscut intersects soft lode matter, consisting of ferruginous gossan and some blocks of solid galena.

No. 6 crosscut is carried 30 feet to the west, the face being in quartzite and schist. Solid blocks of galena are met with in places between the face and the level.

Between No. 6 and No. 7 crosscuts both sides of the level show "sulphide ores" which are said to average 35 per cent. of lead, the remainder being sulphides of zinc, &c., and 10 or 12 oz. of silver per ton. No. 7 crosscut is driven 35 feet to the east, through "sulphide ores," including some blocks of pure galena. These sulphide ores are worked in with the dry ores in smelting.

The 350-feet level is carried southward for 408-feet from the central boundary through the South Company's holding, and is, like the 300-feet level, intersected by crosscuts at regular intervals of 50 feet. No. 1 crosscut, 50 feet from the north boundary, is driven for 35 feet west through "sulphide ores."

"Sulphide ore" occupies the level between No. 1 and No. 2 crosscuts. No. 2 crosscut goes 10 feet east and 30 feet west. The western arm is in "sulphide ore." At this crosscut carbonate of lead begins to appear on the roof of the level, and has been stoped up. At the second floor of the stopes the ore is from 8 to 10 sets wide. The faces of the third floor show ores of very varied character—black and red oxide of copper, carbonate of lead, galena, gossans containing native silver, and "sulphide ore." The fourth floor shows remarkable masses of black and red oxide of copper mixed with carbonate of lead, and a great deal of native copper, which is often beautifully crystallised. At the south face is an immense body of "sulphide ore." In the fifth floor the north face shows gossany "dry ore" containing visible native silver, but very little lead. The north face is turning out kaolin ore and ferruginous gossan containing native silver.

No. 3 crosscut is driven 80 feet east of the level through country rock, and 30 feet west of the level, the last 6 feet in "sulphide ore."

No. 4 crosscut is driven 60 feet to the west, and a winze has been sunk beneath it on 18 feet of carbonate ore.

Between No. 4 and No. 5 crosscuts the level is carried through "sulphide ore." No. 5 crosscut is driven between 40 and 50 feet west, for the first 10 or 12 feet through "sulphide ore," and for the rest of the distance through country rock.

"Sulphide ore" continues from No. 5 to No. 6 crosscut. The latter is driven 10 feet east in country rock, and 50 feet west in "sulphide ore" mixed with country rock.

Between No. 6 and No. 7 crosscuts the level is occupied by "sulphide ore." No. 7 crosscut is at present merely a winze plat in "sulphide ore" on the west side of the level.

The level for 10 feet south of No. 7 crosscut is in "sulphide ore." The succeeding 30 feet of the level are in country rock. Forty feet from No. 7 crosscut, galena commences in the level, which is carried for about 8 feet further. At the face "sulphide ore," containing a large proportion of galena, is met with. No. 8 crosscut is just being commenced.

BRISBANE COMPANY.

The Brisbane Company is boring with the diamond drill on the eastern edge of Block 33, in the hope of striking the main Broken Hill lode. The depth reached on 20th March was 844 feet.*

The workings all along the line prove conclusively the western underlie of the lode, although sometimes it is nearly vertical. A glance at Sands and McDougall's map, already referred to, is enough to show that in the early days the direction of the underlie was an unsettled question, as many "blocks" having been taken up on the eastern as on the western side of the cap. The Proprietary Company's (Wilson's) shaft is sunk from about 80 feet above the level of the diamond drill site, on the hanging wall side of the lode. At the 212-feet level a crosscut is driven from the Wilson shaft for 16 feet west before it cuts the footwall of the lode. The crosscut goes for 170 feet through the lode. The horizontal distance from the Wilson shaft to the diamond drill is about 600 feet. Assuming the absolute correctness of all the above figures relating to the Wilson shaft, the lode underlies at about 41 degrees (from the vertical) to the west, and should have been touched in the bore at about 600 feet. It is needless to say that 41 degrees is an underlie abnormally low, to judge by what is known of the lode elsewhere, and that the bore has not struck the lode at 844 feet proves that beneath the 212-feet level of the Wilson shaft the lode has resumed something like its normal angle of underlie, and certainly underlies at least 30 degrees (from the vertical).†

* 1,207 feet at the end of June, according to newspaper reports.

† Since the above was in print, I have received information regarding the relations of the bore to the main shaft in Block 14. That shaft is 776 feet from the bore, and at a level of, say, 80 feet above it. At the end of June the bore was reported to be 1,207 feet deep. From the shaft, which commences near the footwall of the lode, levels are driven at 200, 300, and 500 feet. The first cuts the footwall at 170 feet, and the last at 410 feet from the shaft. The 300-feet level, however, does not cut it at 300 feet from the shaft. If these *data* be plotted to scale, it will be seen that the lode must run with a low

AUSTRALIAN CONSOLS.

This property lies east of Block 14. The shaft is situated about half a mile east of the eastern corner of that block. A lode runs east and west through nearly level country. It consists, for the most part, of carbonate of iron (siderite) and carbonite of lime (calcite). It averages 1 foot in thickness, but bulges at the lower levels to 8 or 9 feet. The country rock is schist, gneiss, and quartzite, with diorite (the hornblende altered to viridite) in the immediate vicinity of the lode, and chiefly above it. The lode underlies to the south at about 40 degrees. There was little ore of any kind down to 180 feet in the underlie shaft, where a rich shoot of ore was struck. The shoot dipped diagonally across the underlie of the lode in a south-westerly direction, and had been followed down to 280 feet at the date of my visit. It is apparently nearly 40 feet wide in places. The richest part consists of pure native silver, which attains a thickness of 3, 4, or even 6 inches, enclosed in a casing of horn silver, which is probably mixed with sulphide of silver, as it gives sulphur reactions. I saw blocks of over 1 cwt., which must have been fully half silver, being taken out from the bottom of the shaft. A heap of ore weighing 17 cwt. was lying in the assay office, and was estimated to contain 52 per cent of silver—I should say by no means an extravagant estimate. Associated with the native silver and horn silver are stromeyrite (sulphide of silver and copper), a little galena and rich tetrahedrite. The galena in the neighbourhood of the native silver is highly argentiferous.

GENERAL REMARKS.

The first official mention of Broken Hill which I can find is contained in a report by Mr. Warden Gower, of Wilcannia (1883), who states that "some large and valuable deposits of ore have been found at the Round Hill and the Broken Hill, but very little work has been done to test the discoveries, as they are situated so far from any water." Mr. Warden Brown, of Silverton, refers in the Annual Report of the Department of Mines for 1884, to a report issued, apparently, between June and December of that year, by Mr. Harrie Wood, Under Secretary for Mines, which, however, I have not seen. Mr. C. S. Wilkinson, Government Geologist of New South Wales, made a report in August, 1884, "on the silver-bearing lodes of the Barrier Ranges." No other official report by the New South Wales geologists appears to have been published. Mr. Wilkinson's report contains the following observations :—

"The geological formations consist of metamorphosed clay slates and talcose mica-schists, with intrusive masses and dykes of granite and diorite, which traverse the sedimentary rocks, generally in a north-easterly direction, but sometimes in all directions, forming almost a network of dykes. In places the schists pass into gneiss, which imperceptibly changes into porphyritic granite.

"The silver-bearing lodes occur chiefly in the mica-schists in the vicinity of the granite dykes; it would seem as though the contraction of the rocks upon cooling, after the intrusion of the igneous rocks, resulted in the formation of irregular fissures, which became filled with the metallic sulphides and other minerals composing the lodes." [It appears to me that besides the lode matter in the fissures themselves lode matter has in some cases impregnated the adjacent country rock to a considerable distance.]

"The Broken Hill is so called from the rugged outline of its rocky summit. This hill is the highest point on a narrow ridge which runs north-east and south-west for several miles, and forms a conspicuous feature in the district, rising for about 150 feet above the general level of the undulating plain country on each side. The crest of the ridge is formed by the outcropping of a huge lode. The lode varies in width from 10 to 120 feet, and in places rises above the surface in large craggy black masses. It changes in character every few feet, and consists of ferruginous quartzite, quartz-greisen, felspar, porous brown iron ore or gossan, and oxide of manganese (pyrolusite), with patches and veins of crystallised carbonate of lead (cerussite); the occasional black colour of the mass is due to the manganese oxide. Two shafts, one 52 feet deep and the other 50 feet, and about 30 chains apart, have been sunk into the lode, as well as two smaller shafts between these. I did not see any galena in the stuff raised, but I was informed that a little had been obtained; and as the cerussite has evidently crystallised from a solution of lead derived from the decomposition of galena, I believe that masses and veins of galena will be found disseminated through the lode, as in the case of the smaller lodes near the Round Hill on the north-east, and the Pinnacles on the south-west, which are probably the continuation of this one. A sample of porous gossan from near the surface gave, on assay, at the rate of 3 oz. 5 dwts. of silver per ton, with a trace of lead, and two samples, one taken from a vein 18 inches thick of large crystals of cerussite, and another of a finely-crystalline mass of cerussite, from the north shaft, on a different part of the lode, gave, on assay, respectively 1 oz. 12½ dwts. of silver and 73·23 per cent. of lead, and 1 oz. 12½ dwts. of silver and 74·87 per cent. of lead. These results cannot be taken as indicative of the argentiferous nature of the lode, for the galena from which the cerussite has been derived may have been rich in silver, and yet the silver may not have entered into the solution from which the crystals of cerussite were formed. Therefore the richer silver ore will probably be found in association with the undecomposed sulphides of lead and silver, and in the oxidised portion of the lode which originally contained the sulphides.

"Mr. Geo. McCulloch, of Mount Gipps, showed me the results of assays of twenty-six various samples of the ore, taken from different parts of the lode, which gave at the rate of from 4 to 45 oz. of silver to the ton, and 10 to 70 per cent. of lead, or an average of 14 oz. 17 dwts. of silver to the ton, and 46 per

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underlie from the cap to the 200-feet level, but must take a steeper pitch from the 300-feet level, at least as far as the 500-feet level. The most violent curve imaginable would carry the lode down, beyond the 500-feet level, at an angle of 13½ degrees (from the vertical), which would bring the bore in contact with the *footwall* of the lode at 1,980 feet. It is, however, more in accordance with common experience to believe that the lode will keep an *average* underlie than that it will preserve for any great depth the *maximum* underlie imaginable from the *data* afforded by the Block 14 Shaft It is more likely that the underlie at a depth will be something like a mean between that indicated by the Block 14 Shaft and that indicated by the Wilson Shaft, although, on the other hand, the lode in the Wilson Shaft may take the same bend as it does in Block 14 at the 300-feet level. Another reason why the underlie should be less steep is that the strata dip at a lower angle than the lode underlies (see "General Remarks"), and according to common experience a lode will be apt to take a line of weakness, should it meet with one;—in the present case, should the lode meet with less compact strata than usual it will be apt to take for a distance the course of the bedding-planes, or be carried flatter than its general underlie. This is probably what has happened at the 300-feet level (Block 14 Shaft), and the same thing may happen again. Assuming, however, that the bore and lode approach each other at an angle as acute as 13½ degrees, and that the thickness of the lode is, as in the Wilson Shaft, 125 feet (measured, not on the level, but at right angles to the walls), the hanging wall should be met with at 1,415 feet.

46 per cent. of lead. Further prospecting will, I am of opinion, prove this to be a valuable argentiferous lead lode. It appears to dip with the strata about north 40 degrees west at 50 degrees, and on the north-west side sends off several branches. About ten chains from it there is a large dyke of diorite. It is remarkable that no gold has yet been found in the vicinity of these intrusions of diorite." [The workings prove that the lode underlies at a steeper angle than the dip of the strata.]

It is evident that the prosperity of Broken Hill, at least for many years to come, is assured by the quantities of oxidised ores and carbonate ores now in sight. Experiments have been recently made by Mr. John Howell, general manager of the Proprietary Company, who believes that in future, when the supply of water is more plentiful than at present, it will be possible successfully to recover the silver from the "dry ores" by amalgamation, thus doing away to some extent with the necessity of "blending" these ores with lead ores for smelting purposes.

It is, however, more than likely, in view of the enormous quantities of "dry ores," that the Broken Hill companies may actually find it necessary to import lead ores from Queensland or elsewhere to aid in the smelting of the "dry ores." The concentration and treatment of the enormous quantities of low-grade sulphide ores, of which sulphide of zinc and pyrites form a large proportion, is a question which demands speedy solution, and which has an important bearing on the future of some Queensland mines. It may be observed that calamine (carbonate of zinc) is met with occasionally in the Broken Hill mines, but that no deposit of this mineral corresponding in quantity to the immense bodies of carbonate of lead has yet been found. It is worth while here to make an extract from Dr. A. O'Leibin's presidential address for 1891 to the Royal Society of New South Wales:—

"It may not be generally known that the sulphide ores of the Barrier mines carry, in addition to their silver and lead contents, considerable percentages of zinc, sufficient indeed that, could a workable method of extracting and saving it be got, Australia would become one of the world's great zinc-producers. To-day not a ton of zinc is saved from those ores carrying it in important quantities, and we see the strange spectacle of mines with zinciferous lead ores working methods by which attention is directed to extracting lead, worth £12 to £13 per ton, and letting zinc, worth £21 to £23 per ton, go to waste. I may probably be told that it is not worth while to save it while profits can be made without doing so—that it is an annoyance and a trouble; and thus zinc, one of the chief sinners in the so-called 'refractory ores,' has always been looked upon as an enemy. May it not be worth while to make a friend of it?"

There are many mines in Queensland in which the proportion of silver to the ton of ore is greater than the average at Broken Hill, but the experience of Broken Hill shows that skilful management, large quantities of ore, and railway communication to facilitate the importation of fuel and mining timber, are important elements of success.

Mr. Wilkinson's and Mr. Brown's very interesting observations on the appearance of the Broken Hill lode before it was opened out, as well as what I myself saw of the cap of lode, give rise to reflections which may well be taken to heart by the Queensland miner. Except that it was evidently a lode of enormous size there was little to indicate in the early days that it would prove so immensely rich as it has done. In actual silver and lead contents the caps of numerous lodes at Mount Albion, Chillagoe, Newellton, the Etheridge, the Star, the Sellheim, &c., far excel the Broken Hill lode when it first attracted the attention of prospectors. There are immense iron and manganese "caps" of lodes on the Cloncurry, the Mitchell, and elsewhere, which may yet prove to cover deposits of silver not less important than those of Broken Hill.

There is every reason to believe, from specimens which I have examined and information which I have received, that similar country to that of the Barrier Ranges is carried from New South Wales into Queensland by the Grey Range, west of the Bulloo River, and in this district careful prospecting may yet detect argentiferous lodes or auriferous reefs.

I have to record my thanks to Mr. Howell, general manager of the Broken Hill and British Companies; Mr. Thomas, general manager of the Central and South Companies; Mr. Powers, managing director, and Mr. Klug, manager of the Australian Consols, and many other gentlemen for their courtesy in affording me facilities for visiting the mines, and also for the gift of specimens, which have been added to the Survey collection.

ROBERT L. JACK.

Geological Survey Office, Townsville, 15th May, 1891.

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THE PHYSICAL GEOLOGY OF MAGNETIC ISLAND.

(REPORT BY A. GIBB MAITLAND, ASSISTANT GOVERNMENT GEOLOGIST, WITH TWO GEOLOGICAL MAPS AND TWO PLATES OF SECTIONS.)

Presented to both Houses of Parliament by Command.

THE following Report deals with the structure and geological features of Magnetic Island, and includes such a description of portions of the mainland in Cleveland Bay as is necessary to elucidate any special points in its structure or to throw light upon the age of the rocks, and is accompanied by two maps and two plates of sections.

Magnetic Island occupies the western side of Cleveland Bay, and is situated in south latitude 19 degrees 10 minutes, and east longitude 146 degrees 50 minutes. It was named by its discoverer, Captain Cook, in 1770, Magnetical Island, on account of a peculiar deflection of the compass which was noticed on approaching it by sea.

PHYSICAL FEATURES.

The island itself is distant from the mainland at its nearest point, Cape Pallarenda, about three miles, and from the mouth of Ross Creek about five and a-half miles. It is separated from the mainland by a comparatively shallow channel—West Channel—which has an average depth of about one and a-half to two fathoms. In shape the island is rudely triangular, and embraces an area of about ten square miles.

The island is mountainous. The highest summit, Mount Cook, a conspicuous rounded hill covered with forest and fairly dense undergrowth, attains an elevation of about 1,600 feet above the level of the sea. From this point very little of the island can be seen, owing to the luxuriant forest growth. The flanks of the mountain, and indeed the greater portion of the island, are covered with huge rounded blocks of granite of all shapes and sizes.

From Mount Cook the hills are practically arranged radially. One arm extends in a somewhat sinuous course down to Hawking's Point, being divided into a series of semi-isolated peaks, from which excellent views of a great portion of the eastern end of the island can be obtained. The second arm trends right across the island in an exceedingly irregular course to West Point, and has one well-marked hill, Mount Endeavour, near its northern end, overlooking Five Beach Bay, rising to a height of about 1,400 feet above sea-level. The third spur, the most rugged and difficult of access, ends almost abruptly in a bold cliff opposite White Rock on the north. A comparatively isolated group of hills, culminating in Mount Paluma, about 1,000 feet in height, separated from the main mass by a low gap 300 feet above sea level, formed by the head-waters of O'Connel and Gustav Creeks, occupies the eastern corner of the island.

These mountains are drained by many watercourses, which often run in deep precipitous gorges and which are in places well nigh impassable.

With the exception of the south-west coast, fringed by a strip of low-lying land of varying breadth, covered with very long grass, bloodwood, Moreton Bay ash, and occasional ti-tree swamps and mangrove flats, the coast is very precipitous, with deep water, from five to six fathoms, close in shore.

The low-lying land on the south-west coast is skirted, from the quarantine station to Hawking's Point, by a fringing coral reef, but more pressing duties and the unfavourable state of the weather, rendered the examination of the latter an impossibility.

Picnic Bay, a pleasure resort of the inhabitants of the neighbouring mainland, is hemmed in by two headlands, Nobby's Head and Hawking's Point, and seawards by a fringing coral reef, with a channel through it directly opposite the mouth of Camoomilli Creek.

From Picnic Bay round the eastern coast many beautiful minor bays with sandy beaches of varying extent are met with. By far the most extensive and picturesque of these is that known as Horseshoe Bay, on the north coast. It has a width of two miles, and is skirted by a fine stretch of sandy beach along its whole length, and backed by an extensive tract of pretty level well-grassed country, in which a freshwater lagoon or swamp, said to be permanent, exists. The whole bay is encircled by an amphitheatre of lofty, rugged hills, and forms one of the most beautiful spots on the island. It is into this bay that the waters of the most important creeks on the island, which take their rise from the surrounding hills, after finding their way through the broad flat, empty themselves.

PHYSICAL

PHYSICAL GEOLOGY.

The geological structure of the island is comparatively simple, more than three-quarters of it being composed of granite, whilst the remainder is made up of a series of altered volcanic rocks.

The series of rocks exposed within the limits of the area embraced by this Report consists of—

Superficial Deposits (~),
Altered Volcanic Rocks of Permo-carboniferous age (F),
Granite and Felsite (G),

and a series of dykes of basic rocks much newer that any of the other rocks in the area examined.

Superficial Deposits (~).

Under the head of superficial deposits are included the alluvial flats, sea beaches, pumice drift, recent conglomerate, and a coral rock occurring on the sea beach, and best seen at low-water mark. The whole, however, occupy but a very small area of the surface of the island.

The alluvial flats are nowhere very extensive. They are covered mainly with a dark sandy soil, which produces a luxuriant growth of vegetation. The thickness of the alluvial soil, formed by the deposition of the material derived from the decay of the rocks, is very variable. Upon some portions, gardening operations have been carried on with success.

The sandy beaches are very numerous and extensive, the largest being that of Horseshoe Bay. Generally it is found that these sandy beaches form as it were a ridge sloping gradually seawards, but with a steeper slope towards the alluvial flats by which in many cases they are backed. This feature is more noticeable on those portions of the coast which are exposed to the full roll of the breakers.

A considerable quantity of stranded pumice is met with in various parts of the island, notably on those portions which are most exposed to the open sea. The rounded form and somewhat decayed interior presented by many of the pebbles bear evidence of their having travelled some considerable distance, and, as has been noticed by various observers in many of the islands of the Pacific, pieces were found "incrusted with calcareous tubes of the tubicolar annelids *serpula* and *spirorbis*." Stranded pumice was not noticed at a height greater that 12 feet above high-water mark. The source of these pumice drifts is to be looked for in many of the volcanic islands with which the Pacific is known to be studded. It has been proved experimentally that pumice will float for many years ere it becomes so waterlogged as no longer to retain its original buoyancy, and in consequence sink, and hence it is not by any means surprising to find pumice stranded in positions hundreds of miles distant from its original source.

Another not uninteresting feature is the deposit of friable conglomerate and semi-consolidated sand which is met with in the various watercourses throughout the island. These deposits, for want of any better evidence, are regarded as being of recent age. They have been noticed at all levels up to 360 feet, aneroid measurement. The conglomerates are made up of rounded and subangular fragments of the rocks forming the framework of the district. They occur as isolated patches, best seen in the banks of the gullies.

Underlying the alluvial flat formed by the waters of Camoomilli Creek, in Picnic Bay, is a bed of semi-consolidated sand, containing in places a little clay, sometimes white and sometimes yellow in colour. The flats formed by the O'Connel and other watercourses emptying into Horseshoe Bay are underlain by a similar deposit, but from what exposures are visible its thickness does not appear to be so great as in the former place. No organic remains were detected in this deposit, although some time was devoted to searching for them.

Another deposit yet remains to be described—viz., what is known as "Beach Sand Rock."

The best exposure of this rock occurs in Picnic Bay, and it is only to be seen between the high and low-water marks. The rock consists of a fairly coarse brownish-white sandstone, formed of sand grains with fragments of coral and sea shells cemented together by carbonate of lime. It occurs in beds dipping seaward at angles which never measured more than 12 degrees. Passing beneath low-water mark the beds are entirely lost sight of, so that no estimate can be made of their thickness. The outcrop can easily be traced along the beach, at or near high-water mark. A similar deposit is met with near the quarantine station, and occurs at intervals along the south-west coast. Another exposure of this "Beach Sand Rock" is to be seen on the shore to the north of Mount Many Peaks, but the seaward dip is not quite so high as in the beds on the north side of West Channel.

Section 1, Plate 1, from the sea-coast towards the head of Camoomilli Creek shows the relation which these recent beds bear to one another.

Altered Volcanic Rocks (F.)

The altered volcanic rocks occupy but a small area in the western portion of Magnetic Island, near the quarantine station. Excellent sections are to be seen in many of the cliffs which overlook the sea.

One circumstance worthy of note is that the rocks scarcely exhibit any "structure" or "stratification." How far this may be due to the metamorphism which they have undergone since their formation remains to be seen.

When examined in unweathered hand specimens, the rocks do not present many marked points of difference. They nearly all consist of a rock not unlike a quartz felsite, having a compact dark groundmass, through which are disseminated crystals of white felspar. It is when the weathered surfaces are examined that the distinctive points of difference are brought out. By far the greater portion of these surfaces show the rocks to be fragmental in character; pieces of quartz and felspar, and fragments of scoriæ are not uncommon. Some of the rocks, though not many, have all the appearance of some varieties of felstones, and contain no porphyritically developed crystals.

The thickness of these beds cannot be estimated with any approach to accuracy, but there does not appear to be less than 1,000 feet of them.

The

The dense undergrowth and unusually long grass prevented sections, save in isolated places, being examined.

The volcanic rocks, which only occupy a very small area in the north-west portion of the island, can not be well studied. Their characters and such structural peculiarities as they present are much better seen by an examination of the neighbouring mainland than on the island itself.

A section in the bay into which Quorp's Gully empties itself shows an altered conglomerate containing fragments of granite, dolerite, and rocks having a general similarity to the volcanic rocks which occupy this end of the island. The rock is traversed by joints, the joint planes cutting through the embedded pebbles as though a saw had been used. The conglomerate appears to rest upon the volcanic beds. This need not of necessity imply any very great difference in the geological age of the two series. Local unconformities are known to occur in districts subject to the throes of volcanic action. The conglomerate has, however, undergone the same alteration as the rest of the beds. The rounded boulders of granite embedded in the conglomerate are not of the same nature as the main mass of the granite on the island.

"In geological descriptions much is lost by the common practice of failing to show how a district or limited tract is related to its environment, and what part it plays in a grand whole. Without such a correlation a description has little interest or ulterior meaning." (C. E. Dutton, U.S. Geological Survey.) Hence a cursory examination of the country in Cleveland Bay was undertaken with a view to collecting any information or evidence which would tend to throw light upon the structure of the district or the age of the rocks of which the island is composed, and to endeavour to ascertain what relation they bore to those of the mainland.

The hills of which Mount Stuart forms the culminating summit are made up mainly of an intrusive fine-grained granite. A generalised section across this range in an east and west direction is shown in Plate I., Fig. 2. At Stuart's Creek Railway Station a coarse conglomerate is seen to be faulted against the volcanic ashes. These, at a height of 120 feet above the station, on the western bank of one of the heads of Stuart's Creek, show what appear to be bedding planes running north-north-east. Some distance further west, on the fall of the next gully, a few bare scaurs expose instructive sections of rock. The ashes are seen to assume a very coarse character, with fragments about the size of an egg; traced further north these beds pass almost insensibly into what appears to be a medium-grained granite, the weathered surface of which is often pebbly, suggesting the possibility of the granite being metamorphic. A few granitic and felsitic dykes emanate from the main mass of the Mount Stuart granite.

Near the summit of the ridge, west of Stuart's Creek Railway Station, the ashes contain lenticular shaped lava beds, the internal portions of which are wavy and contorted, looking very like fluxion structure, but simulating the appearance put on by some rocks which have been subjected to intense pressure. The exact structure is somewhat difficult to describe in words.

The north-eastern flank of the mountain shows at its base a fair thickness of felstones, presumably lavas, overlaid in places by a very coarse recent conglomerate, made up of large boulders of rocks cemented in an ironstained felspathic matrix. The actual junction of these felstones with the granite is obscured by huge granitic boulders, with which the bed of the creek up which the ascent was made was strewn.

The recent conglomerate is seen to rest upon the granite at elevations about 800 feet above the base of the mountain.

That range of hills designated on the maps by the name of Mount Many Peaks, near Cape Pallarenda, is formed of a series of rocks identical with those of Magnetic Island.

They consist of finely banded ashes with associated agglomerates made up of a tumultuous assemblage of sub-angular and rounded blocks of what appear to be felsite. Some of the beds weather after the usual fashion of ashes, whilst others have the weathering characteristic of felstones. A few of the beds show to the unaided eye a pseudo-fluxion structure, and contain fragments of felsites. The felsitic matrix in which the fragments are embedded weathers into a kaolin-like mass. The whole series has been highly metamorphosed, and in some places quartz appears to have been developed subsequent to the formation of the rocks. At one place at the north-western end of the hills these beds have been penetrated by a dyke of a rock containing felspar and hornblende, embedded in a felsitic matrix.

At Cape Cleveland, the eastern extremity of Cleveland Bay, the rocks are similar to those of Cape Pallarenda, Magnetic Island, and other points in the country drained by waters emptying into the bay. They can be well studied in the splendid but somewhat inaccessible cliff sections. Wherever seen the greater portion of the rocks are ashes, which have undergone alteration so as to almost mask any "structure" or "stratification." Associated with them are felsites, but whether these are intrusive or are lavas poured out at the time the ashes were ejected, the limited time at disposal did not permit of ascertaining.

The result of a microscopic examination of some of these altered rocks is quite in accord with observations made in the field; such an examination shows the greater part of them to be volcanic ashes, and with them true lavas, though one or two, which when examined macroscopically would be unhesitatingly classed with the felstones, turn out to be very fine-grained volcanic ashes.

The following is a description of the general characters of these rocks as seen by the aid of a microscope:—

Quartz Felsite.—The matrix of these rocks is almost colourless by ordinary transmitted light, and is seen to be made up of very fine doubly-refracting matter, the mineral species of which cannot be determined; it appears to resemble a granular admixture of quartz and felspar.

A rude spherulitic structure—*i.e.*, a radial arrangement of microliths of some ferritic substance, can be detected, as also, but though more doubtfully, perlitic structure.

With the aid of a quartz-plate, very minute quantities of the original glassy magma are yet to be seen.

Throughout the matrix fluxion-structure is very common, the lines of flow being seen to bend round the quartz crystals, the felspars, and the fragments of fine ash and other rocks with which the base is studded.

The

The quartz presents all varieties of shapes and forms, from hexagonal crystals to broken fragments. When in crystals the angles are almost always rounded. Liquid (?) or gaseous (?) lacunæ can be seen with a sufficiently high power. The edges of the quartzes are often corroded and eaten into and filled with portions of the groundmass.

The porphyritic felspars (orthoclase) are often altered into a substance which is difficult to determine and to describe. Iron pyrites is met with at intervals.

The fragments of other rocks which occur scattered through the groundmass are mainly fine volcanic ashes, altered dolerites (?), and one of grit (?). Since their consolidation the whole of the rocks appear to have undergone a deal of alteration. Secondary or *gangue-quartz* is of frequent occurrence; this appears to have lined the sides of the cavities (vesicles ?). The internal portions of these cavities are sometimes filled with a greenish chloritic mineral.

In addition to the above evidence of subsequent alteration, some of the felspars show signs of having increased their dimensions at the expense of the groundmass. This can only be detected when the particular crystal is examined under crossed nicols.

The rocks from which the thin slices described above have been prepared are regarded as being lava-flows, which have, when in a viscid condition, assimilated fragments of the rocks over which they flowed.

Mica-porphyrite.—A rock having a very different character to any of the above is seen in a cove near North-West Point. Macroscopically the rock is black in colour, with a resinous lustre, a splintery fracture, and has an average specific gravity of 2·64. In texture it is porphyritic, although the porphyritic felspar crystals are of no great size. When viewed with the aid of a microscope, the matrix is seen to form by far the greater portion of the mass.

The groundmass is in places isotropic, though the greater portion of it has undergone devitrification, and is studded with opaque grains and stained with ferritic matter. Spherulitic structure is well seen when the rock is examined with an $\frac{1}{8}$ of an inch objective. The large porphyritic felspars seem to agree very well in their characteristics with albite: they are remarkably free from decomposition, and contain hexagonal or prismatic crystals of apatite. The ferro-magnesian constituent is biotite, which occurs in hexagonal plates, in size equal to the crystals of felspar. Opaque grains of a mineral, probably magnetite, are scattered throughout the groundmass. A greenish chloritic mineral fills in what appears to have been cavities.

In its general characters the rock agrees very well with what has been termed "pitchstone porphyrite," but the presence of biotite would cause it to be placed among the "mica porphyrites."

Volcanic Ash.—Only one slide of the volcanic ashes has been examined. Under the microscope it is found to consist of angular fragments of felspar and quartz, with a little magnetite set in a matrix, the nature of which, owing to subsequent alteration, cannot be determined. In many places the slide is stained with erriferous matter.

These lavas and ashes emanated from numerous orifices, the remains of which are visible in various parts of the district. Mount Cudtheringa (Castle Hill) and Mount Stuart are two of the most conspicuous of those which occur within the limits of the tract of country embraced by this Report. Another minor vent is to be seen at the northern end of the hills in the aboriginal reserve at Stuart's Creek, due south of selection 206. Here the neck itself is formed of a rock which looks not unlike a granite, but it differs from granite in one or two particulars. Although the minerals of which it is composed are identical with those of a normal hornblendic granite, their mode of association differs. The normal constituents are embedded in a crypto-crystalline stony matrix, which often forms but a small portion of the mass. The peculiar intergrowth of the quartz and felspar, said to be due to simultaneous consolidation, is the feature which distinguishes this rock from the true granites. A rock having these characters is termed a Granophyre. The Granophyre has a peculiar mode of weathering, the surface being often covered with cavities of various sizes, and very often the rock assumes a brecciated appearance. To the east the neck is surrounded with volcanic agglomerate, entirely devoid of bedding. To the south the place of the agglomerate is taken by regularly stratified lavas and ashes, which dip at an average angle of about 5 degrees southwards.

The much larger neck of Mount Stuart is similar in its structure, and the agglomerate by which it is surrounded is pierced by felsitic or granophyric dykes. The age of these volcanic rocks appears to be contemporaneous with the beds at Stuart's Creek, the fossils discovered in which show them to belong to the Permo-carboniferous period.

At Stuart's Creek Railway Station a cutting shows sandstones, shales, impure coal, and an ashy conglomerate, overlain by a sheet of lava.

On the east side of the creek, in the hills in the Aboriginal Reserve, interesting sections show beds of shale and sandstone to be interstratified with the volcanic beds.

At a point nearly due south from the Townley Company's bore a thin sandstone 7 inches thick rests upon an unknown thickness of buff-coloured shale, the whole being overlaid by a sheet of lava.

Near the south-eastern extremity of the hills, at a height of about 180 feet above sea-level, and in the bed of a gully, blue-black shales with 6 inches of an impure coal are seen lying horizontally, overlaid by volcanic ash.

At one spot the shales are "porcellanised," but the induration does not appear to extend for any great distance. These baked shales dip at 25 degrees to the south-south-east. They rest upon and are covered by volcanic rocks. The beds of lava and ash being better able to resist denudation than the associated sedimentary rocks, stand out much more prominently, so that their escarpments can often be traced by the eye for some distance. Save in the banks of the gullies the sedimentary rocks are rarely seen, their outcrop being concealed by screes of volcanic debris. Traces of the shales can often be seen at intervals over a large portion of the hills in the Aboriginal Reserve.

The neck of Granophyre appears to have had little effect upon the sedimentary beds.

In volcanic districts it is not uncommon to find the deposition of sediment going on coeval with the emission of lavas and ashes.

During the time that these beds were being formed the district was subject to continued upheaval and depression, and the interval between such oscillations appears to have been of sufficient duration to allow of the formation of sandstones, shales, and coal seams.

Granite and Felsite (G).

The large area of granite, of which the greater portion of Magnetic Island is made up, is fairly uniform in character throughout its mass.

Its mode of weathering is characteristic of all granite rocks, which leaves huge boulders, often many tons in weight, strewn all over the hill-sides.

The granite is medium in grain, generally of a greyish colour, and is often decomposed for some considerable distance from the surface of the ground. Microscopically it is made up of quartz, orthoclase felspar, and mica; the quartz is clear and pellucid, and contains numerous inclusions. The orthoclastic felspar is altered into a substance which has a "mealy-turbid" aspect. The ferro-magnesian constituent, brown mica, is transformed at times into greenish chloritic matter.

On the northern flanks of Mount Stuart a rock is met with, similar in its mode of occurrence to the basic dykes, and may be conveniently dealt with here. Macroscopically the rock is of a medium grain, and seems to be made up mainly of two varieties of felspar—one reddish-white in colour, and the other almost pure white—and which often occurs in the form of long needle-like crystals, and a dark mineral.

Macroscopically it is seen to be made up of two felspars, orthoclase, which is generally very much altered, and plagioclase in well-developed crystals.

The ferro-magnesian constituent appears to have been originally augite, but is now changed into uralite and chlorite. The quartz occurs in that form known as micropegmatitic or granophyric. Long needle-like crystals or apatite intersecting the quartz and felspar are plentiful throughout the slide, as also grains and crystals of magnetite. This rock agrees in its characters very nearly with the augite-syenite of Rosenbusch, and a rock from Mull, Scotland, described by J. Harris Teall as an augite-granophyre.

At intervals throughout its mass the granite is penetrated by granitic veins much finer in grain than that forming the main body. Those veins are generally seen to contain a far larger amount of quartz than the granite itself. All degrees of texture are to be met with. Some of the dykes traverse the volcanic rocks, and at Stuart's Creek Railway Station dykes of felsite are seen to penetrate beds proved to be of Permo-carboniferous age. (Plate I., Fig. 3.)

In addition to all varieties of texture among these dykes, there is a corresponding difference in their microscopic structure.

A slide prepared from one of the dykes in Retreat Creek, very similar in character to many occurring throughout the rest of the island, was seen to contain all the usual constituents of a granite, with the additions of one or two large crystals of apatite.

Of the felsites two slices from widely-separated localities were examined, and both agree very well in their characteristics.

The most important feature is the presence of true spherulitic structure, and that intergrowth of quartz and felspar known as micropegmatite.

In some cases striated porphyritic felspars are to be seen, but they are clouded with alteration products. One of the slides is traversed by minute cracks filled with some sericitic mineral, as an alteration product.

Basic Dykes.

In many portions of the country examined, a series of dykes of a "basic rock," for which the term "dolerite" is convenient for descriptive purposes, are met with.

These dykes traverse all the other rocks in the district. Viewed broadly, they are parallel one with another; they have a tendency to verticality, but owing to the dense vegetation they cannot be traced for any great distance horizontally. Their characters are best seen on the cliffs to the north of Hawking's Point, where nearly a dozen of them are exposed along the sea beach.

Nowhere do these dykes form any conspicuous feature in the landscape. In one case, owing to the facility with which the material composing the dykes lends itself to denuding agencies, a deep gorge with well-nigh vertical walls has been formed. This feature is best seen at Cape Cleveland, where the gorge in question runs out to sea.

At North Point, and on the east side of it, an east and west vertical dyke, 8 to 10 feet thick, crosses the small bay, and can be traced by the eye up the cliff forming the eastern end of the bay. The rocks through which it cuts are the altered volcanic rocks.

At a height of 160 feet above sea-level, by aneroid, in Quorp's Gully, occurs a dyke 2 feet in thickness, weathering into spheroidal masses.

On the beach extending from North Point to the mouth of Quorp's Gully, several other similar dykes are to be met with; they have all the same general easterly trend, and call for no particular mention. One of these is seen to traverse a felsite dyke, as in Plate II., Fig. 1.

The beach opposite Bay Rock Lighthouse exposes another dyke, which at its thickest part is 3 feet in thickness; this is seen to die out gradually, as in Plate II., Fig. 2.

About 200 feet above sea-level, on a bare scaur at West Point, a vertical dyke 2 feet 6 inches in thickness has a plan as shown in Plate II., Fig. 3.

The granite of Five Beach Bay is traversed by a dolerite dyke, which strikes nearly east and west.

The lower reaches of Retreat Creek, at an altitude of 12 feet, are crossed in a north-easterly direction by a dolerite of the usual type, and which has a maximum thickness of 20 inches.

On the western side of this dyke, another similar one, distant 4 inches from it, and 3 inches in thickness, runs parallel with it. Both traverse the granite of which the bed of this creek is made up.

A not unimportant watercourse, known by the name of Chinaman's Gully, shows at a height of 120 feet, and not far distant from the point where the gully emerges from the mountain another dyke trending east-south-east and 3 feet in thickness.

At Nobby's Head, the westernmost end of Picnic Bay, similar dykes are again seen, whilst on the eastern end of the promontory of which Hawking's Point is the seaward termination, nearly a dozen are to be seen in the cliffs and in the bare rocks, uncovered by the falling tide. The thickness varies from 2 to 3 feet.

In one or two places the dykes have small veinlets branching off from them. A notable case is to be well seen in the face of the cliff upon which the Eagle's Nest stands on Melton Hill, on the mainland, and where quarrying operations are being now carried on. (See Plate II., Fig. 5.) Such offshoots do not, however, appear to be very common.

On the north side of Cape Cleveland a dyke 12 feet in thickness runs west-north-west through the volcanic rocks, and another not far distant from it trends north-west. In the rocks of the Cape a series of joint planes trend north-north-east, with a minor set at right angles to them; along these lines of weakness some of the basic dykes have followed.

At Stuart's Creek Railway Station, in a cutting, the series of dykes as shown in Fig. 3, Plate 2, is well seen.

It is unnecessary to burden the Report with a description of every dyke occurring within the area examined; the position of them will be seen by reference to the map with which this Report is accompanied.

The nature of the rocks forming the dykes bears very much the same general characters, and a description of one from Quorp's Gully will give a fairly good idea of the whole.

In hand specimens the rock is very compact, greenish in colour, with a few crystals of felspar scattered through it, and weathers a rusty brown colour, and has an average specific gravity of 2·8. Examined in thin sections with the aid of a microscope, the slice is seen to be made up of plagioclastic felspar, occurring generally in small prismatic crystals, with a few larger porphyritic crystals which may belong to an earlier stage of consolidation; a ferro-magnesian constituent, which appears to approach more nearly that variety of enstatite containing a high percentage of iron, but which has been altered into a greenish fibrous mineral (bastite?); a small quantity of quartz as grains and broken crystals; a little apatite; an isolated flake of mica, and a not inconsiderable quantity of magnetite scattered irregularly through it. No interstitial matter was detected. A rock with such characters as this would be termed by modern petrographers an enstatite-dolerite.

ECONOMIC PRODUCTS.

One of the most valuable economic products on the island is the alluvial soil formed by the decay of the rocks, and subsequently distributed along the banks of the watercourses. Gardening operations, so far as they have at present gone, have shown the productiveness of this soil.

Some portions of the granite would make good material for building purposes were the proper materials and skilled workmen for dressing the stone at hand. One attempt has been made to make use of the granite from this island, but the experiment, for want of proper means of treating the stone, did not have a very successful issue.

Some of the altered volcanic rocks are capable of taking a good polish, and if they could be obtained in blocks free from joint-planes and the like, they would make fairly good ornamental stones.

Attempts have been made to work one or two of the quartz reefs which are known to occur in various portions of the island.

In no place have mining operations been carried to any extent. At the time the island was visited,* these mines had been abandoned many months, and owing to the recent rains the shallow shafts were all full of water, so that little or nothing could be seen of the reefs.

The following are a few particulars of those reefs upon which any work has been done:—

The Dot (from information supplied), better known as Spark's Reef, is situated at the foot of one of the spurs of Mount Cook, on the south bank of a small tributary of one of the creeks taking its rise from the mountains. It is reported to have been discovered by Mr. Butler, of Picnic Bay, Crown Lands Ranger, who on breaking a specimen of the quartz found a piece of gold in it about the size of a No. 1 shot.

Work is said to have first started in January, 1888. A shallow shaft was sunk to a depth of 10 feet. The total width between the walls is about 10 feet, with 10 inches of quartz on the hanging-wall and 4 on the footwall. At a depth of 10 feet the thickness of the hanging-wall reef is said to have increased to 18 inches. The underlie is about 85 degrees, and the strike appears to be north-west and south-east. The country rock is granite, and the gangue-stuff appears to be little else than a decayed basic rock. Assays have been made of stone reputed to have been taken from here, and one by Mr. J. R. Bradshaw, of Charters Towers, gave as the result—

Gold, 2 oz. 2 dwt. 1 gr. to the ton.
Silver, 0 „ 11 „ 10 „ „

The Butler is situated near the head of Camoomilli Creek. A vertical shaft has been put down to a depth of 8 feet upon a quartz reef 6 inches in thickness, striking north-north-west, and with but a slight underlie to the east-north-east. At the foot of the shaft (now full of water) the reef is said to have increased in thickness to 8 inches. The country rock is granite. Work here ceased about a year ago.

At the head of Knight's Gully—*i.e.*, the gully flowing past Mr. Knight's house—a shaft 6 feet in depth has been put down upon a quartz reef, to which the name of *The Frederick* has been given. There is said to be about 1 foot of quartz, which strikes north-north-west. The country is granite, but beyond this no further information is obtainable.

On the flanks of Mount Cook, on the divide between the waters flowing into Retreat Creek and into Five-Beach Bay, the outcrop of a quartz reef 1 foot in thickness was met with. The strike of the reef is east 10 degrees south. The quartz is very compact, milk-white in colour, and is seen to contain only a very small quantity of iron pyrites.

On

* February and March, 1890.

On the beach, on the east side of Hawking's Point, the association of quartz reefs with the basic dykes is well seen. Here at low water a quartz reef 6 inches in thickness, running west-north-west, is to be seen on the footwall of one of the basic dykes. The general character of the quartz is bluish-white, and the quartz contains but a small percentage of iron pyrites. Near low-water mark the dyke had thinned out to 3 feet, and in it several leaders of quartz run almost parallel with the course taken by the dyke; the bulk of the leaders, however, are on the hanging-wall.

At many spots on the island segregation veins of quartz are by no means uncommon in the granite; they vary in thickness from an $\frac{1}{8}$ inch to 1 foot, and do not appear to be continuous for any distance.

So far as the works have at present gone it cannot be said that the efforts of the prospectors have been successful in discovering a reef of sufficient richness to be payable.

The association of basic dykes with auriferous reefs is a fact long ago pointed out, and in the Gilbert Gold Field the best reefs are associated with rocks which do not differ in any appreciable degree in character and general mode of occurrence from those of Magnetic Island.

Were it not that the position is not very favourable for carrying out mining operations, the small reef occurring with the dyke at Hawking's Point is worth judicious prospecting.

A little alluvial gold is reported to have been obtained at various times from localities in Magnetic Island.

Near the head of Camoomilli Creek a trench 5 feet in depth has been dug in a south-easterly direction for some distance. Here two layers of wash-dirt were met with, the upper one being mainly made up of rubbly gravel, which contains numerous pebbles of quartz and broken crystals, together with boulders of decomposed granite, and a few of grit (?) The upper rubbly gravel was separated from the lower one by about 2 feet of stratified sand with a few pebbles of rock.

A few colours are said to have been obtained by the men who were working there the day previous to my visit; but in three dishes collected in my presence and washed no colour could be detected.

Some distance down the same gully a little work of a somewhat similar nature has been done, but save a few colours nothing payable has as yet been met with. In a gully flowing into Cockle Bay the failure to obtain any encouraging prospects caused the work to be abandoned.

Several other attempts have been made at various times to sink a few shallow shafts, but their importance does not appear to warrant any description of them being given.

In the earlier portion of this Report it has been stated that the reason why the island was named Magnetical Island by its discoverer was a peculiar deflection of the compass which was noticed on approaching it by sea.

In a work by Captain King on the "Survey of the Coast of Australia" mention is made of an analogous irregularity when at work in the mainland in Cleveland Bay. To quote his own words, he states—

"A remarkable observation was here made upon the magnetic influence of this land; the variation was observed to be 10 degrees 32 minutes west, but on moving the compass eight yards off, it only gave 2 degrees 50 minutes east. This in some degree corresponds with Captain Cook's record of the irregularity of his compass when he passed near this part of the coast, in consequence of which he called the peaked island to the west of the cape (Cleveland), Magnetical Island; this irregularity, however, was not noticed by me in my observations near the same spot, and the difference observed by him may very probably have been occasioned by the ship's local attraction, which in those days was unknown."

Large masses of iron, which are to be found in most ships, are known to have a considerable disturbing effect upon the needle, and unless sufficient precautions are taken, the compass may be all but useless. Besides this "local attraction," which can be allowed for, there is yet another cause to which up to the present sufficient attention has not been paid—viz., the influence of geological structure upon the magnetic elements.

A recent paper on the "Relation between the Geological Constitution and the Magnetic State of the United Kingdom,"* by Professors A. W. Rücker, and T. E. Thorpe, of the Royal School of Mines, London, has shown that "forces which produce abnormal variations depend upon the geological character of the district."

Two explanations have been brought forward to account for this—viz., in the first place, "many igneous rocks, and notably basalt, contain magnetic oxide of iron, and the deviations of the needle may be explained by the presence of such rocks, either visible upon the surface or concealed beneath it." The second explanation associates the deflection of the needle with "disturbances of the earth currents of electricity, produced by irregularities in the geological constitution of the country, and especially with geological faults."

A series of experiments show that "igneous rocks, which are very feebly magnetic when tested in the laboratory, produce considerable effects upon the magnet when in large masses." As the result of investigations extending over five years throughout the United Kingdom, the conclusion has been arrived at that the theory of the direct action of magnetic rocks agrees best with the observed facts.

The basic dykes, which are exceptionally numerous in the island and of frequent occurrence in the mainland, contain a fair quantity of magnetite, as does also the sand forming the sea beach.

That the molten matter with which these dykes have been filled emanated from some underground reservoir is more than probable; but the depth at which this nucleus exists is one of those problems which, in its present state, geological science is unable to solve. What effect the magnetite in these rocks will have upon the needle can only be determined experimentally, and such experiments hardly come within the province of the geologist.

Apart from the observations of Captains Cook and King, the writer has been unable to find any record of results of other observers, while upon the coast charts published by the Admiralty in 1864 it is noteworthy that no abnormal variation is noted. A similar observation noted by two observers at widely separated intervals is not without its significance.

It

* British Association. Newcastle, 1889.

It forms no portion of this Report to discuss theoretical questions, but since the above was written a paper upon "Magnetism and Earth Structure," by Dr. E. Naumann, has appeared. The author does not appear to think that what he calls "Rock Magnetism," the explanation adopted by Professors Thorpe and Rücker, is capable of producing any very serious effect upon the magnetic curves, but lays greater stress upon the power of "lines of geological disturbance" in the crust of the earth to "deflect electric currents from their direct track, and cause irregularities in the magnetic elements." Instances are given from various portions of the world showing what effect dislocations have upon them. A case is quoted in Missouri, United States of America, in which the isogonal line of 70 degrees 30 minutes east is effected by the solidified plug of a porphyritic lava in the throat of an old volcano, Pilot Knob.

Remains of old volcanoes occur within the Cleveland Bay district. Can it be that the fissures thus produced have any effect upon the declination, or are the basic dykes or their underground nucleus the cause of the disturbance noticed by the observers?

Neither of the two above considerations are put forward as the true explanation of the phenomenon noticed by the early navigators in Cleveland Bay, but merely to point out that a mass of evidence has been collected during recent years, by which any abnormal variations in the magnetic elements can be accounted for by the geological constitution of the districts in which they occur.

Dr. Naumann points out in the paper abovementioned that a systematic investigation of this, which *primâ facie* appears to be a "purely scientific problem," may, as it has done in the United States of America, "suddenly and unexpectedly become one of great practical importance" owing to "the difficulty experienced in following old boundary lines of landed property which had been originally laid out by the magnetic compass."

A. GIBB MAITLAND.

To R. L. Jack, Esq., Government Geologist, Townsville.

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Geological Survey of Queensland

GEOLOGICAL MAP

of

MAGNETIC ISLAND

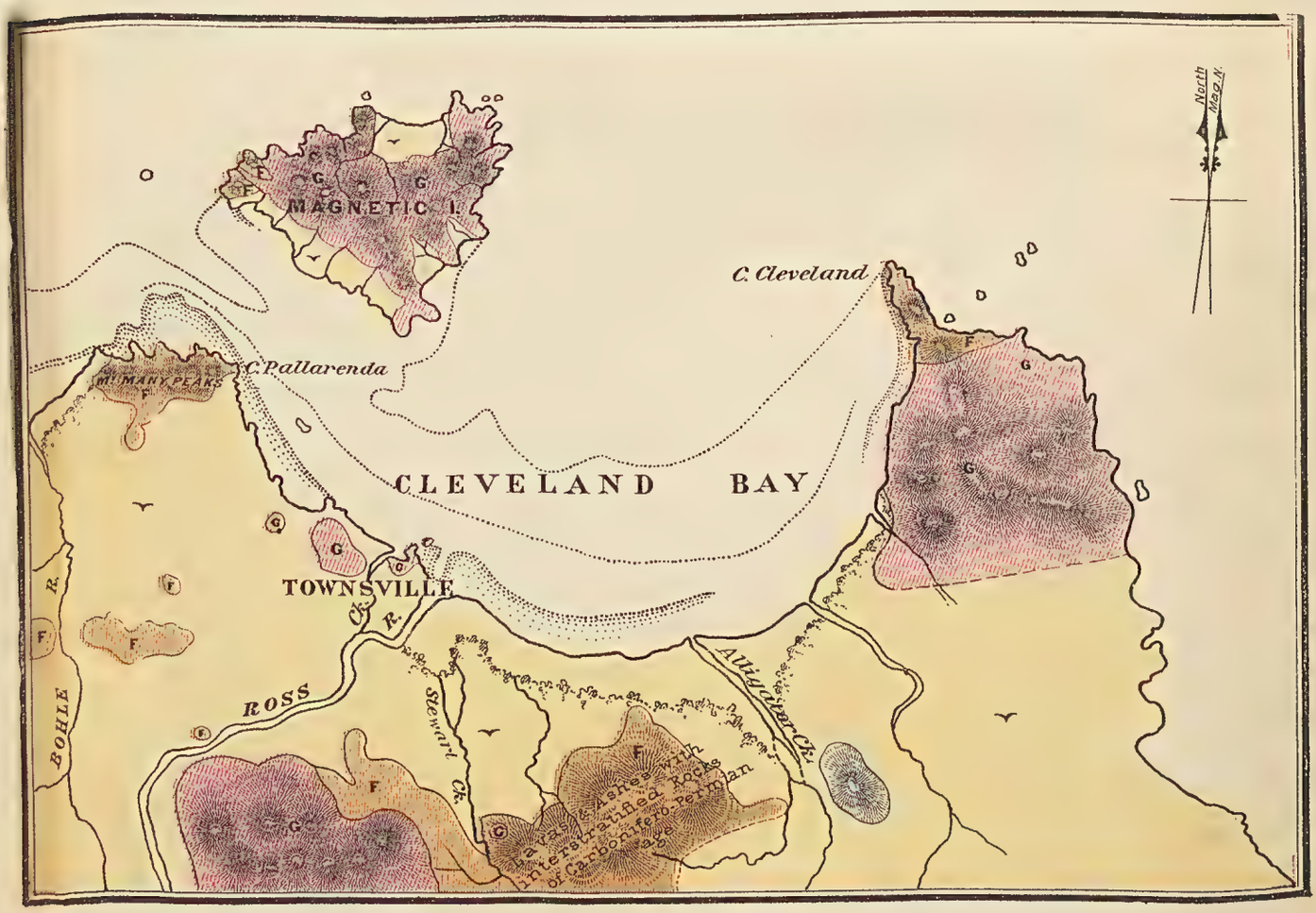
and

Neighbouring Mainland.

Geological Features by

ROBERT L. JACK & A. GIBB MAITLAND

Scale 4 Miles to an Inch



EXPLANATION

Recent Superficial Deposits | *Lavas & Ashes (Permo-Carboniferous)* | F *Granite* | G | *Unsurveyed*

Geological Survey of Queensland.

GEOLOGICAL SKETCH MAP

of

MAGNETIC ISLAND

Cleveland Bay

By A. GIBB MAITLAND

Scale 1½ Inches to a Mile

1 ½ ¼ 0 1 2 3

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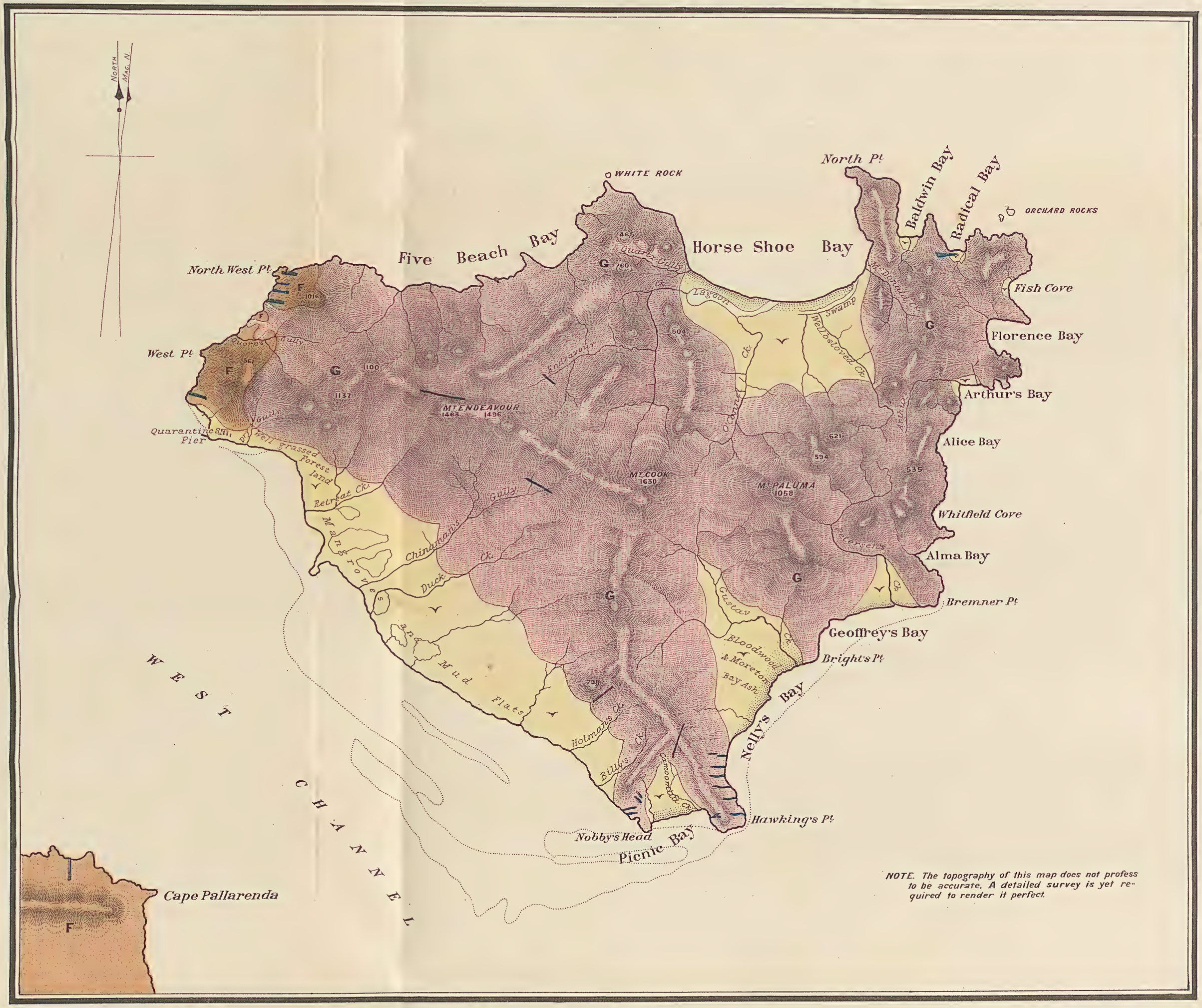


EXPLANATION

Recent Superficial Deposits

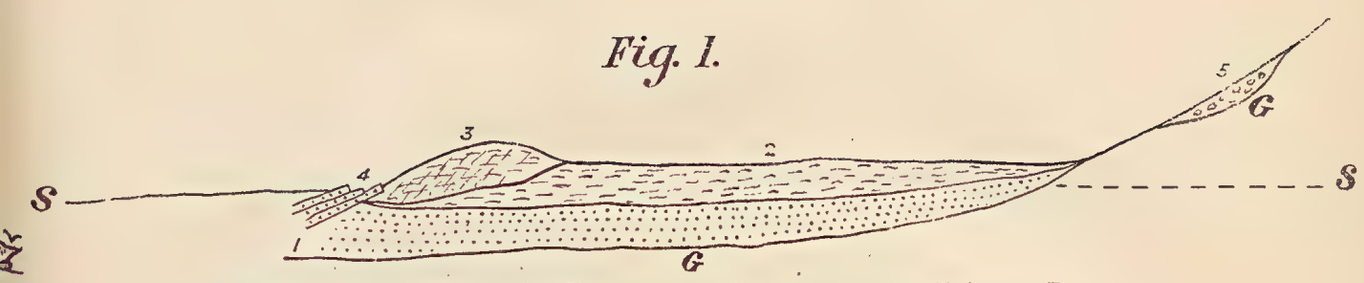
Lavas and Ashes (Permo-Carboniferous)

Dolerite Dykes

Granite (Age undetermined)

Quartz Reefs

Fig. 1.



Section in Picnic Bay, Magnetic Island

S. Low water mark. G. Granite.

1. Semi-consolidated Sand. 2. Recent alluvial soil

3. Sandy Ridge. 4. Beach sand Rock. 5. Recent Conglomerate

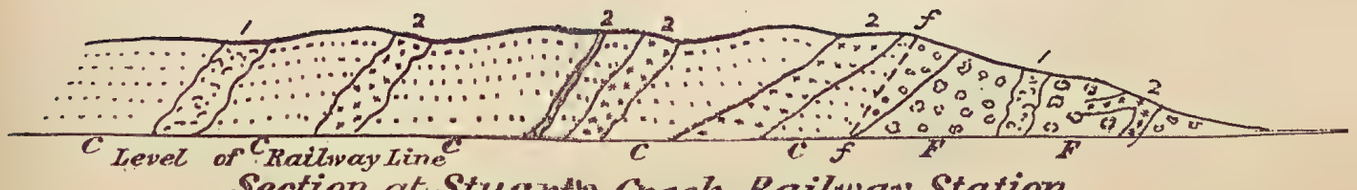
Fig. 2.

Section across Mt Stuart.

~ Recent superficial deposits. C. Coarse Conglomerate.

F. Lavas, Ashes and Agglomerate. G. Granite. D. Dolerite Dyke.

Fig. 3.



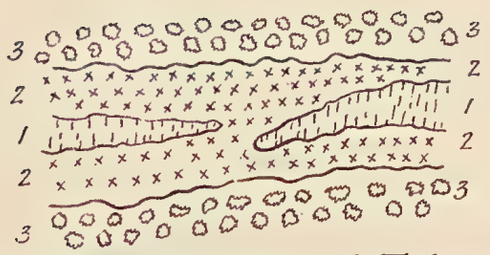
Section at Stuart's Creek Railway Station.

1. Dolerite Dykes. 2. Felsitic Dykes. C. Coarse Conglomerate.

F. Volcanic Ash. f. Probable Fault.

NATIONAL

Fig. 1.



1. Dolerite Dyke. 2. Felsite Dyke. 3. Volcanic Ashes.

Fig. 2.

Plan of Dolerite Dyke

Fig. 3.

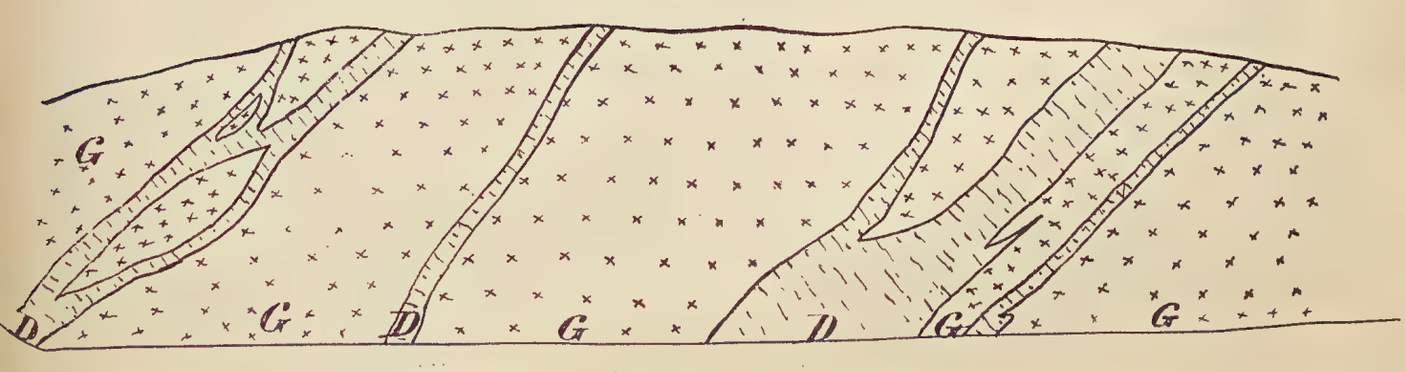
Plan of Dolerite Dyke

Fig. 4.

1. Dolerite Dyke. 2. Granitic Dyke 3. Granite.

Plans of Dykes in Magnetic Island.

Fig. 5.



Section at Melton Hill.

G = Granite. D = Dolerite.

NATIONAL MUSEUM

76

1891.

QUEENSLAND.

MOONDILLA GOLD FIELD.

(REPORT BY ROBERT L. JACK, GOVERNMENT GEOLOGIST, QN)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

This goldfield may be located on the 4-mile runs map of the Adavale district recently issued by the Lands Department, its central point being the tree marked broad-arrow over A, on the (fenced) boundary line between Gumbardo and Milo Runs. In its brief existence it has already been referred to as the "Adavale," the "Hoomooloo," and the "Gumbardo" Gold Feld. It is situated in the midst of a region which has hitherto been regarded as composed solely of Cretaceous rocks, and consequently a very unlikely place for the occurrence of gold. Reports have spoken of it as occurring on a "range," but the rise is scarcely perceptible; in fact, the place may be said to be a slightly—very slightly—puffed up portion of a flat. Deep wells in the vicinity have turned up shales of the Lower Cretaceous formation, but on the field itself something still more recent makes its appearance at the surface.

About two miles west of the camp is a hill, rising to perhaps 80 feet above the general level, and composed of a ferruginous grit, getting coarser in places till it becomes a conglomerate, and interbedded with white, hardened clay or shale. The grit has all the usual characteristics of the once widespread formation known as Desert Sandstone or Upper Cretaceous.

Returning to the goldfield (which, so far as prospecting operations show, is about a square mile in extent), we find that its groundwork consists of what is known as "cement," a somewhat consolidated "wash" of materials for the most part siliceous, but to some extent felspathic. This cement, on being broken up and washed, is found to contain a considerable quantity of hydrous silica, which is not in rounded waterworn grains, but in concretions or nodules. Sometimes the silica, when present in large quantities, forms lenticular concretionary masses, and even what may be called beds, strata or seams interstratified with the cement. When these beds attain any thickness they present almost every variety of the chalcedony group of hydrous silica, varying in colour from smoky to yellow, pearly, milk-white, and water-clear, and, while breaking with great facility (with a conchoidal fracture) into "knives" or "flint-flakes," can be seen on every surface and in every thin section to have a nucleated structure throughout.

The above characteristics, and above all its low specific gravity, would enable any miner to distinguish this from the auriferous stone of any hitherto known goldfield. The low specific gravity is, of course, due to the fact that water enters into its composition, so much of it as is water being only two-fifths of the weight of an equal bulk of common anhydrous quartz.

If it be permissible mentally to reconstruct the conditions under which the goldfield was created, we may imagine, in the first place, a land surface on which the Upper Cretaceous (Desert Sandstone) lay on the Lower Cretaceous (or "Rolling Downs") strata. In course of time the Desert Sandstone was denuded till mere fragmentary tablelands of it remained *in situ*, the debris of the portion removed being spread over the surrounding low country. From abundant evidence furnished by other parts of Australia, it is known that at a period (Newer Tertiary ?) when the denundation of the Desert Sandstone had gone on for some time immense outbursts of volcanic activity took place, giving rise in some cases to flows of basaltic lava, and in others to fountains of warm water. We may presume that the latter was the case at Moondilla, and that the water was highly charged with dissolved silica, of which it carried quantities into the then loose and incoherent masses of debris formed of the waste of the Desert Sandstone. The silica, at first in a gelatinous condition, would eventually be segregated into concretions surrounding nuclei or filling up spaces or openings in the bedding-planes, and on consolidating and crystallising would have no difficulty in elbowing portions of the cement matrix out of the way and assuming the gnarled and twisted forms presented by the majority of the concretions and seams. In all probability the thicker beds of silica represent pools of silica-charged water which were ultimately covered up by further accessions from the debris of the Desert Sandstone. With the silica a limited amount of gold appears to have come up in solution, and to have been deposited with it, possibly precipitated by the agency of sulphate of iron. The portions of the silica richest in gold are those which are seamed with iron oxide.

The silica occurring in the cement has evidently had a similar origin to that which forms comparatively thick beds. It is not waterworn, and has not been carried by running water, but is concretionary—the result of the segregation, around nuclei, of a certain amount of the same material, once more widely disseminated throughout the surrounding mass. There is no reason to suppose that the gold, any more than the silica, was carried from a distance, or emanated from any reef which may be discovered by trenching or sinking.

It

It is a very natural conclusion that the auriferous rocks of Moondilla must be a continuation of the Broken Hill and Mount Brown country, but I can say with confidence that there is no point of resemblance between the two. The granites, gneisses, schists, slates, &c., of the Barrier Ranges have no representative, so far as I could discover, at Moondilla.

The Moondilla country is, in ordinary seasons, a very dry one, but, the geological conditions being favourable to the discovery of artesian water, infinite possibilities of profitable working are open should payable gold be found. Even as it is, I consider that the Colony has been appreciably enriched by the recent discovery, which must attract attention to the presence of gold under conditions which are certainly new, and which may prove to be of great importance.

The foregoing remarks may be dismissed as theoretical by the "practical man," who will demand an immediate answer to the question whether the field is payable or not.

I have seen a number of very rich specimens, and there can be no doubt of their genuineness. No other known field could supply auriferous specimens which would pass for Moondilla stone to the extent of deceiving anyone who had seen the latter. I have also been shown a number of fair prospects, and have spent a considerable time inspecting and prospecting the stone and cement. Without entering into particulars, I may say that they gave average prospects which, in my opinion, were considerably below the line of the payable, although they demonstrated the presence of gold. A very large proportion of the stone already stacked could not possibly pay for handling, although small quantities of payable stone could, no doubt, be picked from the heaps.

It is quite possible, seeing that small patches of rich stone have been found, that larger patches may yet be met with either here or in the extensive areas in which a similar formation is reported to occur.

As I had the opportunity of visiting the field in company with Major Moore, the Warden of the district, I expressed my opinion to him in the presence of a number of prospectors and claim-holders; and as it proved that my opinion corroborated his own, he declined for the present to take the responsibility of provisionally proclaiming the place a goldfield, judging that a perfectly unwarrantable rush might set in, and be followed by hardships and distress.

The following, from a trench in "No. 1 East" Claim, may be taken as a typical section:—1. Red soil, 1 foot; 2. Silica, 1 foot; 3. Cement, with bands of silica, 3 inches; 4. Cement, with horizontal lines of cavities, a yellowish stain, and small concretions of silica, 1 foot 8 inches; 5. Silica, 0 to 3 inches; 6. Same as No. 4, 10 inches; 7. Cement, with bands of silica, sometimes coming together into a thick bed, 1 foot 3 inches.

The silica beds sometimes attain a thickness of 3 feet, and in some cases thin out rapidly, so that it would be impossible to say, without continuous working, whether beds seen in shafts a few yards distant are identical or not. On the "range" the first silica bed is generally met with within three feet of the surface; but some shafts have not met with any thick bed. The deepest shaft, so far, is 15 feet. A bore is in progress, and has reached the depth of 49 feet, and from the last drillings I saw "colours" of gold and minute specks of native copper. "Colours" of gold can be obtained in many places from the soil and cement as well as from the silica.

ROBERT L. JACK.

Langlo River, 26th September, 1891.

Price 3d.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

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QUEENSLAND.

ALLUVIAL CINNABAR DEPOSIT NEAR KILKIVAN.

(REPORT BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST, ON)

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Sir,—In accordance with instructions received from Mr. R. L. Jack, Government Geologist, I proceeded to Kilkivan to examine and report upon a discovery of alluvial cinnabar on Mactaggart and Party's selection, No. 2,447.

Mr. Dan. Mactaggart, in his letter to the Minister for Mines dated 17th June, 1891, a copy of which was forwarded to me for my information, speaks of this as "the first discovery of a 'lead' of alluvial cinnabar in these colonies." This, however, is not strictly accurate, as Mr. S. L. Hester discovered alluvial cinnabar some years back at Kilkivan itself; and in my annual report for the year 1886 I mentioned the occurrence of cinnabar in a drift near the Wolf claim, where some heavy pieces of alluvial cinnabar were found. A small parcel of the alluvial ore returned as much as 60 per cent. of mercury.

Mr. Jack informs me that alluvial cinnabar is already known to occur on the tributaries of the Percy River, itself a tributary of the Gilbert River.

Alluvial cinnabar also occurs in New South Wales on Spring Creek, near Bingera; and near Cudgegong, Mudgee.

I believe, however, that this may claim to be the first alluvial cinnabar that has given prospects of being able to be worked profitably.

A short account of the Kilkivan cinnabar lodes will be found in my report* on the Kilkivan district.

The lodes in this district occur in a number of different rocks.

Those near the heads of Wide Bay Creek, a short distance west of the Black Snake, occur in mica and chlorite schists. The "Old Man" lode is situated in these rocks.

About four miles further down the creek is the Wolf cinnabar lode, which occurs in beds of sandstone, carbonaceous shale, and conglomerate, dipping 14 degrees to the west. The shaft on this lode is 240 feet in depth. This is the greatest depth at which cinnabar has been found at Kilkivan.

The lodes in selection 1,886, amongst which are the Godfrey lode—the first discovered in the district—and the Queensland cinnabar lode, selection 2,682, are in much altered sandstones and conglomerates; with beds of agglomerate, probably of organic origin.

The lodes in selection 2,447 (about five miles west of Kilkivan railway station), from which the cinnabar in this alluvial "lead" has undoubtedly been derived, occur in a coarse-grained granite, consisting of pink felspar, black biotite mica, and large blebs of quartz.

Surrounding this granite is an altered dark-coloured rock, with porphyritic crystals of felspar through it.

The lodes occur on the northern slope of a ridge, running in the form of a crescent through the selection, and not far from the junction of the granite and the altered porphyritic rock, which follows round near the summit of the ridge.

The Commotion Lode.—In the tunnel there is a regular "stockwork" of veins, the richest of which run about north-west and south-east. Some of the veins have little or no matrix, but consist of small bunches of ore in the granite. Others contain a matrix of quartz and calcite. In the shaft of the Commotion there is a distinct lode from 2 feet 6 inches to 3 feet in width, consisting of a granitic material with calcareous clay veins running through it. The shaft is about 30 feet in depth. Near the surface there were very rich patches of high grade ore—that is to say, ore containing about 50 per cent. of mercury—in bunches up to 6 or 7 inches in width.

The lode runs north-west and south-east with a slight underlie to the north-east. The shaft is sunk right on a "shoot" of the ore, little or no ore occurring on either side of the shaft. No driving has been done on the lode in search of other "shoots." Rich ore occurred on the footwall of the lode at a depth of 20 feet.

The

* Report on the Geology and Mineral Resources of the Districts of Kilkivan and the Black Snake, by William H. Rands, Assistant Government Geologist. Brisbane: By Authority, 1886.

The Central.—This shaft is 6 chains west 31 degrees north of the Commotion shaft, and is 23 feet in depth. The lode is of the same granitic character, with leaders of quartz and calcite running through it. The granite of the lode is much softer than that of the surrounding country. This lode is a continuation of the Commotion lode. The richest patches of ore were from 4 to 5 inches in width, but the veins vary in size a good deal and are very patchy. The lode bears north-east and south-west, and has a north-easterly underlie. The level of the surface here is about 30 feet higher than at the Commotion shaft. This shaft is also on a "shoot"; the ore runs out at each end of the shaft.

One and a-half chains a little north of west of this shaft the junction of the granite with the altered porphyritic rock, which forms the southern fall of the ridge, is visible in the cutting, running where it is exposed in a direction west 10 degrees north.

The Bloodworth Reef is 10 chains west 31 degrees north of the Central shaft. The shaft is down 20 feet in depth. Two small leaders showing cinnabar, each about 1½ inches in width, occur about 6 inches apart. They run in a direction north 10 degrees east.

The cinnabar in all these workings is very much crystallised. The richest ore found in the district has come from these lodes.

Alluvial Cinnabar.—The alluvial cinnabar "lead" occurs in the flat leading down from the Commotion lode. (See plan.)

Three shafts have been sunk, in all of which alluvial cinnabar has been obtained.

Shaft No. 1 is 40 feet in depth. The rock at the bottom of the shaft is an altered porphyrite rock, similar to that on the southern fall of the ridge. The wash-dirt consists of a granite drift, with large pebbles of the altered porphyritic rock, and it contains small waterworn pieces of cinnabar throughout it, and occasional pieces of over one pound in weight. The wash-dirt is about 4 feet in thickness. Drives have been put in across the drift for a distance of 25 feet, and cinnabar has been obtained throughout. I tried two prospects from this shaft and obtained fairly good results.

Shaft No. 2 is about 4 chains south-west of No. 1, and higher up the gully. It is 20 feet in depth. The bottom of the shaft is granite. The wash-dirt is about the same thickness, and of the same character, though curiously it consists of a finer drift, although situated higher up the flat. I obtained fairly good prospects from this shaft also.

Shaft No. 3 is 5 chains nearly west-south-west of No. 2. I did not go down this shaft, as it was of much the same character as the other two.

There appears to be no defined gutter or channel in the "lead," and the cinnabar is distributed throughout the whole of it.

Mr. William Hester and I washed 1 cwt. of the wash-dirt from the drift that had been carted to Messrs. Hester Bros.' Quicksilver Works, about a mile and a-half from the claim. The result was poor, only 4 ozs. of cinnabar being obtained from the 1 cwt. of dirt. There were, however, none of the larger pieces of cinnabar in it, which often occur, and which add considerably to the general percentage.

The wash-dirt can be got easily, and if it is economically worked I am of opinion that it will pay. It is not rich enough to cart away for treatment, and there is no permanent water in the creek close to the "lead" for sluicing purposes, but a dam could be made in the creek at no great expense.

The following is a complete return of the amount of quicksilver obtained from the Kilkivan District up to the end of October, 1891:—

		Quantity of Quicksilver.	
1874 to 1876.	Hester Bros.	68 bottles	or 2·3 tons
1887.	Kilkivan Cinnabar Co.	9 „	or 0·3 „
1891.	Mactaggart Bros.	47 „	or 1·5 „
	Total	124 „	or 4·1 „

This year's yield of 1·5 tons was obtained from 28 tons of stone taken from the lodes in Mactaggart Bros.' selection, No. 2,447. The stone has thus averaged about 5·3 per cent.

WILLIAM H. RANDS,
Assistant Government Geologist.

Price 9d.]

By Authorit : James C. Beal, Government Printer, William street, Brisbane.

GEOLOGICAL SURVEY OF QUEENSLAND

Mineral Selection 2447

Altered Porphyritic Rock.

Creek

Bloodworth lode

Granite

Boundary of Granite

"Lead"

Alluvial Shaft N°1 40 ft. dp

Alluvial

Alluvial Shaft N°2 20 ft. deep

Alluvial Shaft N°3

Central Shaft

Commotion lode

Approximate boundary of Granite

Altered Porphyritic Rock

Gully

Commotion Shaft & Tunnel

lode N°5

lode N°6

LOCAL SKETCH

RANGE DIVIDING WIDE BAY AND BURNETT WATERS

Kilkivan Stn

Ck

RAILWAY LINE

KILKIVAN

2447

Wide Bay Ck

Coppermine Ck

Jims One Mile Ck

Hester Brothers Quicksilver works

Plan to accompany report on alluvial Cinnabar deposit near Kilkivan

BY WILLIAM H. RANDS. ASSISTANT GOVT GEOLOGIST.

Scale 4 Chains to an Inch

1891

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1892.

QUEENSLAND.

SAPPHIRE, GOLD, AND SILVER MINES NEAR WITHERSFIELD.

(REPORT ON, BY ROBERT L. JACK, GOVERNMENT GEOLOGIST.)

WITH A MAP.

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

SAPPHIRE MINES.

Leaving the Central Railway at Withersfield Station (203 miles from Rockhampton) and taking the Keilambete Road, Retreat Creek is reached, just below the mouth of Spring Creek, in a distance of about twelve miles north-north-east. For the first three miles from Withersfield the road passes over sandstones and shales which bear a considerable resemblance to, and are probably identical with, the strata seen on the Drummond Range between Bogantungan and Hannam's Gap. ("Star Beds" in the Classification adopted by the Geological Survey.) These strata are probably of Carboniferous age, since they form one of the lowest Subdivisions of the Permo-Carboniferous System as developed in Queensland. The Drummond or Star Beds are characterised by the last appearance of *Lepidodendron*. Their place will be seen at a glance from the following table, showing the members of the Permo-Carboniferous system:—

Upper Middle Lower	Bowen River Beds
Star Beds	(with *Lepidodendron*)
Gympie Beds	,, ,,

About three miles from the Railway, granite is met with on the summit of the low divide between the waters of Borilla and Retreat Creeks, and continues for about a mile to the north. As they approach the granite mass, the stratified rocks just mentioned become more and more disturbed and indurated, and are frequently intersected by dykes of basaltic rocks and acidic felspar-porphyries. The sandstone beds, which, normally, have a grey or a greenish-grey tint, due to protoxide of iron, become purple or red from the peroxidation of the iron, and assume a tendency to spheroidal weathering.

On the northern slope of the divide, the granite gives place to mica schist, which appears to be the prevailing rock *in situ*, until, after crossing Retreat Creek, gneiss is first met with.

The Mineral Selection No. 3022, on the left or northern bank of Retreat Creek, is indicated by dotted lines on the four-mile Map, and therefore was probably unsurveyed when the Map was compiled. Its position, it may be mentioned, is slightly incorrect, insomuch as it is wholly above, instead of directly opposite the mouth of Spring Creek, as it is shown on the Map. Keilambete Station lies about three miles up the Creek, also on the left bank.

Modern alluvial flats border Retreat Creek, the lowest and most recent (which is very limited in extent) being about ten feet, and a second about twenty feet above the level of the stream. Opposite the house on the Selection, and about a quarter of a mile back from the Creek (no modern alluvial here intervening) is a fragment of what is evidently a very old alluvium, probably about fifty feet above the level of the stream. The drift or wash of this alluvium situated in the Selection constitutes the Upper Workings, and in a fragment of similar drift, about two miles to the east, are the Lower Workings of Messrs. Richardson and Fisher's Sapphire Mines.

Resting upon a bottom or bed-rock of gneiss, whose upper portion is weathered to a clay, of which the topmost three or four inches is generally reddish from the peroxidation of the iron-bearing minerals, is a gravelly drift, the pebbles consisting mainly of sandstone and conglomerate, both altered to quartzite, with a comparatively small number of quartz, hæmatite, and a hardened dark slaty rock. The drift is generally very shallow, being rarely as much as three feet deep, but is crowded with an extraordinary number of immense boulders of sandstone, quartzite, and conglomerate-quartzite especially in the Lower Workings, which are on a slightly lower level than the Upper Workings. The conglomerate-quartzite boulders contain pebbles, chiefly of quartz, so well cemented in a siliceous matrix that when broken with a hammer they split up through the quartz pebbles as freely as through the matrix. The portions of the boulders exposed above the soil are generally much weathered and split up, but the buried portions are rounded and smooth. The large boulders form, in places, the great bulk of the drift,

drift, and are, as it were, packed with finer pebbles and small gravelly drift. Sapphires and other precious stones are found among the smaller pebbles of the drift, especially around and beneath the large boulders. It is said (and so far as I could see with justice) that the sapphires, &c., are more numerous in proportion as the boulders are larger. Some are even found a few inches down in the clay. It is very likely that the surface of the gneiss in the ancient river bed was hard and solid, and that the decomposition of the gneiss to a clay took place after the locality ceased to be the main channel for the drainage of the district. The red clay is apparently not a *deposit*, as it is entirely unstratified, and is exactly such as would result from the decomposition of the gneiss, into which it insensibly graduates.

A good deal of trenching and excavation has been done in Messrs. Richardson and Fisher's Upper and Lower Workings, especially the latter. The washdirt is carted to a perforated trough opposite the house on the Mineral Selection, where it is cleaned from earth and sand by a jet of water thrown on it by a Tangye pump connected with a large hole in the Creek, after which it is sorted by hand on a table. East of, and nearly adjoinining the Lower Workings, is Messrs. Morgan and Ballard's Mineral Area, in which, at a slightly lower level, a similar drift is visible; but no means of washing the drift having as yet been provided, operations have been confined to trenching, and the picking up of sapphires which are visible on the surface, especially after rains. I may mention that I saw in the possession of the manager a waterworn sapphire weighing about seven ounces.

While I was on the spot two small loads of washdirt, weighing, as I judged, about a ton and a-half in all, were taken from among the boulders at the Lower Workings and carted to the sorting trough. Through the perforations in the bottom of the latter all earthy and sandy material and gravel under the diameter of three-sixteenths of an inch were speedily washed, and the cleaned contents of the trough were then wheeled to the sorting-table. The result was 258 sapphires of from 3 to 179 carats each, and weighing in all 3,289 carats; and 25 zircons of from 3 to 64 carats, and weighing in all 257 carats. The sluicing of the finer material beneath the trough (which was said to include the tailings from about twenty previous loads of dirt) yielded many thousands of smaller sapphires and zircons (the latter in greater proportion among the small than among the large stone), pleonaste, white topazes, magnetite, hæmatite, and scales of gold. I failed to detect a single garnet either among the larger or smaller stones.

The sapphires are for the most part more or less abraded and waterworn, and often fractured. Their original crystalline form is, however, frequently recognisable. Double hexagonal pyramids are rare, as the fracturing seems to have almost always taken place near the bases of the crystals. Weathering and abrasion have in many cases produced finely pitted surfaces, which render the stones perfectly opaque; but even in such cases any fresh fracture will almost always show the stones to be more or less translucent. Some, however, show their translucent or transparent nature even in the rough; but it is only when such stones are cut and polished that their value as gems becomes apparent. Many are dark blue; a smaller number are of a perfect "royal blue." Some present distinct alternations of blue and green laminæ in the direction of the cleavage of the crystals. A few, being entirely green, are the "oriental emerald" of jewellery—not the emerald of mineralogy, which is a beryl (silicate of aluminium and glucinium). Many of the stones show a blue tint when viewed in one direction, and a green when viewed in a direction at right-angles to that showing blue. In fractured specimens, the "asteria" or six-rayed star of reflected light is frequently met with. With the useful little instrument, the dichroiscope, all exhibit marked dichroism—that is to say, no matter what translucent portion of the gem is viewed through the instrument, two differently coloured images of it will be presented. The instrument thus affords a ready means of distinguishing between minerals which crystallise after the monoclinic system and all others, as well as between glass imitations and the gems which exhibit dichroism. Thus sapphires may be distinguished from blue spinels, and rubies from garnets and red spinels, although they may be so fragmentary or so artificially deformed that no trace of their crystallisation can be recognised. The specific gravity of one of the sapphires which I took to Townsville was found to be 4·007. It is difficult to understand why, among such a profusion of sapphires, the much-prized red variety known as the oriental ruby should be conspicuous by its absence; but so it is, so far as the workings have yet shown. Mr. Richardson has, however, in his possession two sapphires which show spots of red. If these portions could be cut away from the surrounding matrix, they would be rubies in a mineralogical sense.

From what has already been said as to the opaque surface of the stones it will be readily understood that it is often a matter of considerable difficulty to distinguish the stones which are fit to be cut for gems from those which can only be used as emery. Often this cannot be done until one or more faces have been polished, although the value of a certain proportion of the stones can be observed at once. It is not with any idea of assessing the value of the mine, but merely for the purpose of presenting a definite idea to the mind of the reader, that I hazard a guess that among the larger stones perhaps one in a hundred may be fit for some use in jewellery, while perhaps one in two thousand may be a sapphire, oriental emerald, or oriental topaz of the first water. A few cut stones in the possession of Mr. Richardson appeared to be equal in value to some of the finest gems in the great mineralogical cabinets of Europe. Even the occasional discovery of one such gem would more than repay many months of labour, and the chances are that systematic working will lead to the discovery of many.

It may be mentioned that sapphires are known to occur in other localities in the Colony—for instance, in the stream-tin workings at Stanthorpe, and with alluvial gold on the Russell and Gilbert Rivers; but, so far as I am aware, no other deposit is known in which they occur in such numbers or of so high a quality as at Withersfield.

Next in importance to the sapphires are the (Hyacinth) Zircons. Many of these are of fine rich colours, ranging from that of the ruby to port wine, sherry, and straw yellow. The specific gravity of specimens taken to Townsville ranged from 4·66 to 4·67.

Some of the zircons could be cut into stones which would be difficult to distinguish from rubies, except by their higher specific gravity and inferior hardness. The peculiar property of this mineral, whose colour can be entirely discharged by the application of heat, has given rise to its substitution for the diamond, which, when colourless, it resembles both in lustre and refraction, although it is a good deal heavier and much softer. Very fine large cut hyacinths, not professing to be either rubies or diamonds, have been sold for about fifty-six shillings per carat, but their value is said to be on the decrease.

The

The source of the sapphires, &c., remains as yet undiscovered. No trace of any adherent matrix was observed on the stones which came under my notice. The mineral pleonaste was reported to occur in the basalt of Mount Leura, about nine miles north-west of the Upper Workings, and it was plausibly argued that, as pleonaste occurs plentifully in the wash, associated with sapphires, &c., the source of the latter might also be found in this basaltic mass. With the view of setting this matter at rest, I visited Mount Leura and found the supposed pleonaste to be large pitch-like masses of titaniferous iron (menaccanite). Mount Leura is a conical mountain, rising about seven hundred feet above the general level of the surrounding country. The lower three hundred feet of the slopes consist of granite, buried beneath a talus of immense boulders of basalt; while the upper part of the mountain is composed entirely of the latter rock. This cone is evidently a "puy" or focus of eruption of basaltic lava, but whether the basalt overflowed any portion of the low country cannot be ascertained with certainty. From the summit of the mountain an extensive view to the north-west, north, and north-east showed a nearly level country dotted over with similar conical "puys."

The conglomerate-quartzite and sandstone-quartzite of the Upper and Lower Workings, and of Morgan and Ballard's Workings can be recognised without difficulty as the débris of the Desert Sandstone formation, which has been entirely denuded from the drainage area of Retreat Creek. The great size of the boulders would appear to indicate that they cannot have travelled any great distance from their original site. Probably cliffs of the Desert Sandstone formed the walls of the valley of the creek or river represented by the gem-wash. The river must have been a large and impetuous wartercourse—probably much too large to have been confined within the present basin of Retreat Creek. It must be remembered that the boulder and gem-wash occurs only in fragments, sometimes lying on the highest ground in the neighbourhood, these fragments having probably been preserved from denudation owing to the accumulation of the hard quartzite boulders, while the adjacent softer country-rock was channelled by a new system of drainage. It is not at all likely that a large creek or river, such as this must have been, had in its bed only the few feet of drift now remaining. It is more probable that a considerable quantity of gravel and sand once covered the heavier boulder drift in the bottom, although only the latter, from its obdurate nature, was able to resist denudation. It appears to me therefore extremely probable that the sapphires, &c., came from the same source as the quartzite boulders, viz., the Desert Sandstone, and that, if they are to be found *in situ*, the locality may be looked for further to the west, where, on the divide between the Barcoo and the Burdekin waters, a large area of Desert Sandstone has, so far, escaped denudation. No diamonds have as yet been found associated with the sapphires, although in other parts of the world these two minerals have been met with in the same wash. Where this is the case it may be suspected that the diamonds and sapphires have been derived from distinct sources, although within the same drainage area. It is difficult to imagine any common "genesis" for pure alumina and pure carbon. Hence I do not regard the presence of sapphires as necessarily implying the presence of diamonds.

GOLD.

A second ancient watercourse is met with, in a fragmentary condition, between Ruby and May Creeks, about four miles south-south-east of Mr. Richardson's Camp. This watercourse is represented by a gravelly and sandy wash, capped by a narrow basaltic flow extending from west to east. I was informed by Mr. Charles Bradford that the basalt can be traced in patches to this locality from the neighbourhood of Mount Leura. If this be the case the present watercourses (Retreat, Spring, and Ruby Creeks) must have been excavated *across* the line of the old valley. This wash is at present being worked for gold, good prospects having been obtained from it in several places. I visited the Workings (locally known as the Basalt Hill Diggings) after having inspected the Sapphire Mines.

Bradford and Harvey.—A prospecting shaft sunk at the head of a gully, from which payable gold has been obtained, gives the following section:—

Basalt débris	3 feet
Ill-consolidated sandstone waste, containing, near the bottom, large boulders of granite, schist, and quartzite	25 „

This is on the north side of the basalt capping, near its eastern end. It may be mentioned that a branch of the same gully, rising in schist and slate country, a little further to the north, and not draining the basalt or underlying wash, was found to be destitute of gold. Another shaft, also on the left bank of the first-mentioned gully, and about ten feet below the level of the basaltic plateau, gave the following section:—

Basalt	10 feet
Layer of gravelly wash	25 „
Sandstone wash	
Gravelly wash with fine gold	
Gneiss bottom.	

A little further west (still on the left bank of the gully) and at a slightly lower level, a drive to the south, ending in a "monkey shaft," shows a thickness of at least ten feet of coarse gravel beneath ill-consolidated sandstone wash.

Biddle's P. A. (9th December, 1891).—On the top of the plateau to the south-west, a shaft is being sunk in search of the drift beneath the basalt. The present depth of the shaft is seven feet. The basalt is very hard.

Bradford's P. A.—Mr. Bradford has attained a depth of six feet in the basalt with a shaft about four hundred yards north-north-west of Mr. Biddle's.

I was informed by Mr. Bradford that small sapphires are found with the gold in the basalt-capped wash of the Basalt Hill Diggings.

Should the above prospecting operations prove successful, as is likely enough, the wash-dirt can be conveniently sluiced in May Creek, and the further tracing of what may be called the "deep lead"—although the overlying basalt is of no great thickness—will no doubt be attempted.

It is evident that the basalt, although now forming the highest part of a plateau, must have been poured down a valley, covering the alluvial deposits of the stream. On its consolidation, its hardness being superior to that of the adjacent country-rock, the drainage would be forced to excavate new channels in the latter, and portions of the ancient alluvia would be preserved from denudation by the resistance offered by the overlying basalt.

A little gold, together with small sapphires and zircons, has been obtained from the bed of Ruby Creek. The name of the Creek has, of course, been derived from the presence of the zircons.

About three-quarters of a mile south of the Basalt Hill Diggings, in the midst of a country-rock of alternating slate and schist, some holes have been sunk on a bed of the latter, which in places is more than usually ferruginous, and in other places shows carbonate of copper on the joint-planes. It is said that an assay of this rock gave from three to four ounces of silver per ton.

SILVER MINES.

Freedom of Contract No. 1.—This Claim lies about a quarter of a mile from the left bank of Ruby Creek, and about two miles south-east of the Upper Sapphire Workings. A blow of gossany ore is seen on the south-west side of the shaft. The ore runs out of the shaft, and is followed and worked out in a short drive and shallow chamber beneath the gossan seen at the surface. It is mullacky (*i.e.*, mixed with country-rock), red in colour, and occasionally stained with manganese oxide and copper carbonate. The shaft is continued, on a low underlie, to a depth of fifty-five feet, following to the south-east a thin seam of red clay, which intersects quartzite and an instrusive sheet of fine-grained granite, which cuts into and out of the quartzite several times within the limits of the underlie. It is proposed ultimately to drive from the bottom of the underlie to beneath the chamber already referred to. The deposit is in reality a pipe vein, with what may be called a thin flange-vein running down from it, and it is quite possible that the flange-vein may be connected with other pipes at a lower depth.

About a ton of ore lies at grass, having been taken from the shaft only a few feet from the surface. The ore is a mixture of iron oxide and blue carbonate of copper, with a little green carbonate of copper. I was informed that seven tons of ore had been sent to Aldershot for treatment, my informant stating that of this quantity only about two tons were of good quality, while the rest ought not to have been sent. The returns from the seven tons averaged nine ounces of silver per ton, with a small percentage of copper.

Freedom of Contract No. 2.—This Mine lies on the eastern side of the Road from the Sapphire Mines to Borilla Railway Station, between Retreat and Ruby Creeks, and about two miles south of the former. The country-rock is mica-schist. A shaft has been sunk to a depth of forty-eight feet on the underlie of a lode to west 30 degrees north, the schist dipping to the east. The upper part of the shaft is vertical, but an old underlie shaft, now covered up by the mullack-heap, followed the lode from its cap down to the bottom of the vertical portion of the shaft. The lode is pretty distinctly traceable for about one chain along a line running south 30 degrees west from a point about a chain and a-half from the shaft. The cap of the lode consists of brown hæmatite slightly stained with copper. I was informed that a portion of the cap gave, on assay, four ounces of silver per ton, no lead, and 17 per cent. of copper. Some green ore was obtained in the shaft at the depth of about twenty feet. A small parcel of ore (about two cwts.) lies at grass. It consists of brown hæmatite, bornite (sulphide of copper and iron), and green carbonate of copper. Besides the ore, there are lying about the shaft fragments of serpentine, fibrous serpentine (crysotile), and indurated kaolin. The deposit here can at least be said to occur as a true lode.

Freedom of Contract No. 3.—This property lies between Mount Pleasant (a slate hill) and the right bank of Ruby Creek, opposite No. 1. It is about a quarter of a mile from the Creek. A prospecting shaft has been sunk vertically to the depth of thirty-five feet, in search of possible lodes, through diallage rock, with vertical joints running north-west and south-east. The rock is occasionally veined with black vitreous magnetic iron ore. Beds of quartzite are seen in the immediate neighbourhood of the shaft, striking north and south, and containing fine pyrites, its joints being coated with iron oxide.

Hobbs and White (abandoned).—Near the eastern end of Mount Pleasant is the cap of a large ironstone lode, said to have assayed well for gold.

Bradford's P. A. (2nd December, 1891).—A shallow shaft has been sunk on an east and west lode, which is said to have given good prospects of gold at the surface. The cap shows red ironstone, which becomes yellow in the shaft.

ROBERT L. JACK.

Geological Survey Office,
Townsville, 29th January, 1892.

Price 1*s.*]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

MAP OF WITHERSFIELD DISTRICT

To accompany Report

by

ROBERT L. JACK

Scale 4 Miles to an inch

4 3 2 1 0 4 8

1892

Basalt B. Granite G.

NATIONAL MUSEUM VICTORIA

83

1892.

QUEENSLAND.

MOUNT MORGAN GOLD DEPOSITS.

(THIRD REPORT ON THE, BY ROBERT L. JACK, GOVERNMENT GEOLOGIST.)
WITH TWO MAPS, FOUR PLATES OF SECTIONS, AND TWENTY VIEWS.

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

In the end of December and beginning of January last I spent fifteen days at Mount Morgan, and the following Report embodies the observations made during that time. The chairman of Directors rendered me every possible assistance, and I have, as before, specially to record my thanks to Mr. Roger Lisle, Manager of the mine, for the care and pains with which he pointed out every circumstance which had interested him in his long experience, as well as for the complete arrangements which he made for my guidance through those portions of the mine opened out since my previous visit.

The Chairman courteously placed the services of the Company's Assayers, Messrs. Leipner and Eisenstaedter, at my disposal, and during my visit these gentlemen assayed 178 specimens which I had selected from the various faces and tunnels. I have retained samples of each specimen assayed. The locality from which each sample was taken will be found on Plan II. and Plates V. to XXIV. by reference to the number enclosed in parentheses in the text.

The Report is intended merely to bring the record of Mount Morgan up to date, and does not deal with any theoretical questions. The sections and plans tell their own tale. For one thing, although the mine has already turned out over a million ounces of gold, the sections show that only a very small proportion of the *known* amount of payable ore has been excavated.

SURFACE WORKINGS.

The surface excavations have been greatly extended since my last visit, a large part of the hilltop having been reduced to the level of No. 4 Bench. There are two main excavations to this level, the No. 4 Bench proper and the Lady Musgrave Bench. The walls surrounding these benches are carried up with a steep batter. I made a compass and tape traverse of the outer edges of the benches (see Plans Nos. 1 and 2) for the purpose of showing their extent and positions. The superficial area of both of these benches is as nearly as possible equal, each being 2 roods 13½ perches, or, together, 1 acre 27 perches.

With the view of showing the present condition of the mine, I employed Mr. J. H. Lundager, of Mount Morgan, to make a series of twenty photographs of the walls surrounding these benches. The photographs are reproduced by photo-zincography,* and have references printed on them showing the places from which characteristic samples were taken for assay. The photographs were not taken from a central point, and so do not form a panorama; but, on the contrary, each section was taken from the most appropriate point of view, so as to secure as good an illustration of its geological features as was possible in the circumstances. The letters *A*, *B*, &c., on Plan No. 2, correspond to similar letters on the views; each of the latter, with a few exceptions, representing a horizontal distance of one chain. Descriptions of the various sections follow.

NO. 4 BENCH.

I to J—Plate V.—(in reality from midway between *I* and *J* to *J*, *I* being on the Lady Musgrave Bench), 33 feet from east to west, near the mouth of the road by which the mullock is wheeled to the tip. A fragment of the outer end of the old No. 2 Crosscut is seen on the western side of the view.

The rock surrounding the mouth of the crosscut is composed of ironstone, in large boulders, or rather nodules. Outside of the ironstone is a mass of soft yellow and red, partly siliceous and partly felspathic rock, most probably a sinter, but possibly a decomposed siliceous and quartz-felspar dyke. It appears to underlie the ironstone. Two specimens assayed, No. (139) a trace, and No. (140) 11 dwts. 10 grs of gold per ton.

J to K—Plate VI.—Continuation of *I* to *J* westward, 33 feet. All that remains of the old No. 2 Crosscut (the angle near its eastern outlet) is seen in this view.

It may be convenient here to quote from my Second Report† a description of No. 2 Crosscut. As the greater part of the rock has now been excavated from the surface down to the level of the crosscut, it may be presumed that the anticipations entertained in 1889 as to its payable quality have been realised:—

"A branch tunnel (see Section E) commences 220 feet from the south end of No. 2 Tunnel, and runs east till it comes out on the hillside at a distance of 310 feet. This branch is crossed 16 feet from the main tunnel by a felstone dyke (18 inches wide). As far east as this dyke, and a little beyond, the sinter

* By Mr. Murray Fraser, of Brisbane. † Brisbane: By Authority, 1889.

sinter is a good deal stained with iron oxide. Thence onward to the east the sinter is nearly white. For about 136 feet from the main tunnel the branch (with the exception of the narrow dyke) intersects light, soft, siliceous sinter, in which, according to Mr. Lisle, gold varied from 1 oz. 2 dwts. to 32 ozs. per ton. Sixty-two tons treated gave a return of 5 ozs. 6 dwts. gold per ton. At 216 feet from the main tunnel the siliceous sinter is a good deal mixed up with silicate of alumina; and thence eastward, although it loses the silicate, it has a tolerably distinct dip east at about 25 degrees and is poor in gold. Towards the east end the sinter becomes again more ferruginous, till in one place it is a mass of black ironstone boulders pretty rich in gold. A white siliceo-felspathic material, enclosing elongated nodules of pure silica and containing some free hydrochloric acid, at the mouth of the tunnel, has a rude dip of about 60 degrees down-hill (east) and may be partly surface-wash."

The greater part of the material described in the above quotation has been removed, with the exception of the portion near the mouth of the crosscut shown in the view *J* to *K*. It may be presumed that the material remaining beneath the level of the excavated portion of the tunnel is of similar quality to that which has been removed.

The great bulk of the rock exhibited in this view is composed of ironstone in large boulders, or rather nodules. A specimen (141) from between the two outlets of the fragment of the old tunnel assayed 4 dwts. 21 grs. of gold per ton. The ironstone is occasionally, especially in its upper portions, somewhat siliceous and earthy. West of the crosscut is the soft, partly siliceous, and partly felspathic rock referred to in the preceding description.

K to L—Plate VII.—This section, seen from the north-west, embraces part of the outlet from the bench, from the inner end of the fragment of the old No. 2 Crosscut, and part of the eastern face of the bench itself.

A fragment of a decomposing felstone dyke peeps over the upper part of the face, with a "hade" or underlie to the east,—*i.e.*, behind the sinter seen in the foreground. At the southern end of the section, above the old No. 3 Bench (of which only a narrow shelf remains), is a mass of ironstone, which is replaced further north by yellow-stained sinter. A specimen (149) from the latter assayed 9 dwts. 19 grs. of gold per ton. A specimen (151) of the ironstone last mentioned assayed 1 dwt. 15 grs. of gold per ton.

From the level of No. 3 Bench down nearly to that of No. 4 Bench, the bulk of the rock in the section is ironstone, similar to that in section *J* to *K*. There is, however, a lenticular mass of yellow siliceous sinter at the angle between the No. 4 Bench and its outlet. A sample (142) from this assayed 1 dwt. 15 grs. of gold per ton. From the ironstone itself four samples were taken, and assayed—No. (150), 8 dwts. 4 grs.; No. (143), a trace; No. (147), 6 dwts. 12 grs.; and No. (148), 9 dwts. 19 grs. of gold per ton.

Commencing at the angle above mentioned, at the level of No. 4 Bench, and gradually rising southward till at *L* it attains an elevation of about six feet above the bench, is a mass of loose white siliceous sinter-sand; its upper portion stained yellow where it comes in contact with the ironstone. Three samples of this were taken and assayed—No. (144), at the angle, 3 dwts. 6 grs.; No. (145), midway between the angle and *L*, 13 dwts. 1 gr.; and No. (146), at *L*, 11 dwts. 10 grs. of gold per ton.

L to M—Plate VIII.—In this section (which continues Section *K* to *L* further south), the loose white sinter gradually increases in thickness southward, and at the same time becomes more and more mixed up with kaolin. A specimen (154) midway between *L* and *M* assayed 4 dwts. 21 grs., and another (155) near *M* assayed 1 dwt. 15 grs., of gold per ton. The upper part of the sinter is stained yellow, as in the preceding section, where it comes in contact with the overlying ironstone. At the southern end of the section an intrusive mass, or dyke, of felstone comes nearly to the top of the sinter, but does not intrude into the ironstone above.

Near *M* the mouth of a small exploratory tunnel connecting No. 4 Bench with the Lady Musgrave Bench is seen in the lower part of the ironstone mass. A specimen (156) broken from the mouth of the tunnel assayed 1 oz. 4 dwts. 12 grs. of gold per ton. Up to the level of the old No. 3 Bench the greater part of this section, above the sinter, is ironstone, but a small mass of white sinter is seen in the upper southern corner.

The greater part of the face above No. 3 Bench is composed of a yellow sinter, with two irregular masses of ironstone, while at the top the felstone dyke referred to in the description of Section *K* to *L*, as peeping from behind the sinter, is again seen. A sample (152) from the middle of the sinter (having nothing in its appearance to suggest that it was exceptionally rich) gave an assay of 17 ozs. 4 dwts. 15 grs. of gold per ton. A sample (153) from the southmost mass of ironstone gave 13 dwts. 1 gr. of gold per ton.

M to N—Plate IX.—This view continues the view *L* to *M* further to the south, the southern half being part of the old Magazine Face referred to in my first Report.*

In the northern part of the section are seen the intrusive mass of felstone referred to in the description of Section *L* to *M*, with the kaolinic sinter immediately above it. The latter apparently comes abruptly to an end, being cut off by a mass of lumpy ferruginous and siliceous sinter. The sinter and the ironstone are not here capable of being separated by a distinct line, as in *L* to *M*, but the deposit is a mixture of both. A sample (157) assayed 16 dwts. 8 grs. of gold per ton. A distinct band of yellow ferruginous sinter overlies the ferruginous and siliceous sinter, dipping at about 30 degrees to the south in the upper half of the section, and in the lower half coming down vertically, in an attenuated form, to the level of No. 4 Bench. This is surmounted by a white sinter which describes, in the upper half of the section, the same singular curve, and in the lower half extends horizontally to the south as far as *N*. A thin felstone dyke penetrates this vertically near its northern end, but thins out entirely about 10 feet above No. 4 Bench. A specimen (158) from this white sinter assayed 6 dwts. 12 grs. of gold per ton.

A small dome of ironstone rises up at *N* from the floor of the bench for a few feet into the white sinter. A sample (160) assayed 14 dwts. 17 grs. of gold per ton, and gave also a trace of silver.

Above the white sinter is a large mass of black and red iron-stained sinter, graduating near *N* into ironstone. A sample (159) of the iron-stained sinter assayed 3 ozs. 11 dwts. 20 grs. of gold per ton. A specimen (161) of the ironstone just south of *N* assayed 11 ozs. 16 dwts. 20 grs. of gold and 3 dwts. 6 grs. of silver per ton.

Above

* Brisbane: By Authority, 1884.

Above the ironstone at *N* a mass of kaolinic sinter mixed with ironstone dips to the south with the fall of the hill.

The disposition of the layers met with in this section seems to me explicable only on the theory that a cup or hollow, *whose centre lay further to the south*, was filled up successively by muddy materials of varying composition, and that successive renewals of hydrothermal activity again and again carved out the greater portion of the deposit, when subsequent calmer conditions more favourable to deposition covered the remnant with fresh deposits—to be afterwards treated in the same way. On *purely theoretical grounds*, therefore, I should expect a continuation of the auriferous deposits to be met with to the south of *N*, unless the denudation of the hillside (here rather steep) has entirely removed it.

From a point midway between *M* and *N* to the point *O* is a face of kaolinic sinter, rising a few feet above No. 4 Bench to the level of a slightly higher bench, which extends southward till it is met by the contour of the hillside.

Next in order comes the western walls or faces of the No. 4 Bench, from the point *O* northward.

O to P—Plate X.—The whole of this view shows practically the north-eastern side of a large felstone dyke (the kaolin dyke alluded to in the First Report), although a few inches, or in some cases a few feet, of white cellular siliceous sinter have been left adhering to it. A specimen (162) of this sinter assayed 1 oz. 2 dwts. 20 grs. of gold and 1 dwt. 15 grs. of silver per ton. Another specimen (163), from an iron-stained fissure in the sinter near *P*, which was said to have given good gold a few feet back, assayed 9 dwts. 19 grs. of gold and 1 dwt. 15 grs. of silver per ton.

P to Q—Plate XI.—This view continues the section *O* to *P* further to the north. A narrow shelf of the old No. 3 Bench is seen in the background. Up to the level of No. 3 Bench the rock seen is mainly a white cellular siliceous sinter. Above No. 3 Bench the rock is mainly ironstone. A felstone dyke intersects both the ironstone and the sinter near the northern end of the section. It traverses the floor of No. 3 Bench, the apparent break in it being an effect of perspective. The large kaolin dyke of the previous section is behind the ironstone out of sight. A sample (164) of the siliceous sinter assayed 6 dwts. 12 grs. of gold per ton. A specimen (165) of the ironstone above No. 3 Bench assayed 3 dwts. 6 grs. of gold per ton.

Q to R—Plate XII.—This view continues the preceding further to the north. In the left or southern end is the felstone dyke seen in *P* to *Q*, the apparent break at the level of No. 3 Bench being again due to perspective. In the foreground is seen a few planks covering the mouth of the Crown Shaft or Main Pass down which the ore is shot to the lower levels, and the mouth of the remaining western fragment of the old No. 2 Crosscut.

Up to the No. 3 Bench the rock is a white cellular siliceous sinter, with the exception of the dyke already referred to and another which is seen below the level of No. 3 Bench and behind the mouth of the No. 2 Crosscut. The latter dyke has been broken through, and a small excavation made in the sinter behind. Above No. 3 Bench the southern portion of the view shows ironstone, and the northern portion ironstone mixed with sinter. A specimen (167) of sinter from the south side of the southmost dyke, above a small bench between Benches Nos. 3 and 4, assayed 4 dwts. 21 grs. of gold per ton. Another (168), from above the mouth of the Crosscut, north of the northmost dyke, and a little below the No. 3 Bench, assayed also 4 dwts. 21 grs. of gold per ton. Another (169), of the sinter above *Q*, assayed 3 dwts. 6 grs. of gold per ton. Two (170 and 171) of ferruginous sinter, presenting no apparent difference in composition, and taken from contiguous spots 15 feet below No. 3 Bench behind the knob of sinter, near *R*, assayed—No. (170), 4 dwts. 21 grs. of gold per ton; and No. (171), 1 oz. 2 dwts. 20 grs. of gold and 1 dwt. 15 grs. of silver per ton. A specimen (166) of sinter from the mouth of the old No. 2 Crosscut assayed 6 dwts. 12 grs. of gold per ton.

R to S—Plate XIII.—extends from the Crown Shaft and mouth of No. 2 Crosscut to the north corner of No. 4 Bench. Up to the level of No. 3 Bench the rock is siliceous sinter. Above No. 3 Bench is a knob of ironstone, behind which some payable stone is being worked.

S to T—Plate XIV.—33 feet from west to east across the northern corner of No. 4 Bench. A portion of the ironstone knob last referred to is seen at the west end of the view, and a felstone dyke is seen further to the east. The bulk of the view shows siliceous sinter, which is ferruginous in the upper portion, and more or less iron-stained beneath. In the centre, against the sky-line, is a large block of ironstone shot from the knob above.

Specimens were selected from different localities in the sinter. Specimen (172), from near the felstone dyke, assayed 3 dwts. 6 grs. of gold per ton. No. (173) assayed 1 oz. 2 dwts. 20 grs. of gold and 1 dwt. 15 grs. of silver per ton. No. (174), a white sinter, assayed 1 oz. 11 dwts. of gold and 1 dwt. 15 grs. of silver per ton. No. (175), a ferruginous sinter, assayed 1 oz. 19 dwts. 4 grs. of gold and 3 dwts. 6 grs. of silver per ton. No. (176) assayed 1 oz. 9 dwts. 9 grs. of gold and 1 dwt. 15 grs. of silver per ton. No. (177) assayed 17 ozs. 14 dwts. 10 grs. of gold and 3 dwts. 6 grs. of silver per ton. No. (178) assayed 3 ozs. 11 dwts. 20 grs. of gold and 1 dwt. 15 grs. of silver per ton.

T to U—Plate XV.—continues the section south-eastward towards the outlet of No. 4 Bench. The greater part of the section shows yellow kaolinic sinter, which is surmounted by a comparatively thin layer of ironstone. Both are said by the Officers of the Company to be much poorer at the present face than where they have been excavated.

U to V—Plate XVI.—Continuation of the same from west to east towards the outlet of No. 4 Bench.

LADY MUSGRAVE BENCH.

I to H—Plate XVII.—North-west to south-east this view shows a mere fragment of the Lady Musgrave Bench (practically on the same level as No. 4 Bench), and part of the face of the Lion's Den Bench, which is excavated 27 feet below. Near *I* is seen the mouth of the little exploratory tunnel mentioned in describing section *M* to *L* of the No. 4 Bench.

The bulk of this view shows, down to the level of the Lady Musgrave Bench, ironstone similar to that seen on the eastern face of No. 4 Bench, but high up, in the south-eastern half of the view, is a mass of fine-grained, loose, white siliceous sinter, its lower part stained yellow with iron oxide. Two samples of the ironstone from beneath the Lady Musgrave Bench assayed—No. (132), 16 dwts. 8 grs., and No. (133), 6 dwts. 12 grs., of gold per ton.

Below

Below the Lady Musgrave Bench the ironstone is seen to rest on a white kaolinic sinter, the upper portion of which is masked by iron oxide and stained red and yellow. A sample (134) of this discoloured portion assayed 5 ozs. 14 dwts. 8 grs. of gold per ton. Specimens of the white kaolinic sinter assayed—No. (135), 16 dwts. 8 grs., No. (136), 6 dwts. 12 grs., and No. (137), 4 dwts. 21 grs., of gold per ton.

H to G—Plate XVIII.—continues the preceding section southward, showing the floor and face of the Lady Musgrave Bench. In the right hand of the view is the corner of the lower Lion's Den Bench.

The upper part of the face above the Lady Musgrave Bench consists of yellow and red spongy ironstone, a specimen (129) of which assayed 3 dwts. 6 grs. of gold per ton. Beneath this is a mass of loose white siliceous sinter, its lower part stained red and yellow with iron oxide. This mass presents a very irregular outline, only to be accounted for, I think, by denudation. Its southern end is seen in this view, and its northern end is well defined in the preceding view (*I* to *H*). Samples from the iron-stained lower portions assayed—No. (128), a trace of gold, and No. (131), 1 dwt. 15 grs. of gold, per ton. The underlying ironstone is understood to be poor (although it was richer where it has been excavated). A sample (130) assayed 1 dwt. 15 grs. of gold per ton.

G to F—Plate XIX.—Continuation of the preceding section south-eastward. The details of part of *G* to *H* are repeated in the right-hand part of the view. South-east of *G* is the mouth of what remains of the old Lady Musgrave Tunnel.

The bulk of the material between *G* and *F* is ironstone. A specimen (127) near the mouth of the tunnel assayed 14 dwts. 16 grs. of gold per ton. An adjacent specimen (126) had visible gold. Another specimen (124) of the ironstone midway between *G* and *H* assayed 6 dwts. 12 grs. of gold per ton. Another (122), near *F*, had visible gold. Midway between *G* and *F* a mass of yellow siliceous sinter rises a few feet above the floor of the bench. Samples of this assayed—No. (125), 8 dwts. 4 grs., and No. (123), 2 oz. 2 dwt. 11 grs., of gold per ton. At *F* a mass of white kaolinic sinter rises above the level of the bench, but is partly concealed by a talus, and is better seen in the next section.

F to E—Plate XX.—continues the preceding section to the southern end of the Lady Musgrave Bench, where the latter is cut off by the fall of the hill.

In the northern end of the view, ironstone occupies the greater part of the section, its base, which is very irregular in outline, rising from north to south at an average angle of 15 degrees. A specimen (120) assayed 1 oz. 1 dwt. 5 grs. of gold per ton. Sample (121) was kept for a museum specimen.

The white sinter referred to at the conclusion of the description of the preceding section underlies the ironstone, and occupies the greater part of the remainder of section *F* to *E*. It is interrupted near *E* by two felstone dykes. The proportion of kaolin to silica in the sinter varies a good deal, and various shades of red and yellow are produced in different places by the oxidation of iron. A specimen (119) from a yellow portion assayed 1 dwt. 15 grs. of gold per ton. Another (118) from a red portion assayed 3 dwts. 6 grs. of gold per ton.

E to A—Plate XXI.—North-east, 105 feet. This section and those which follow constitute the eastern face of the Lady Musgrave Bench.

Between *E* and *A* the foreground consists of light white kaolinic sinter, behind which is a felstone dyke. Four samples from this face very well exemplify the varying nature of the gold-contents of the sinter. There was nothing in their appearance to suggest that one was richer than another. Nos. (99) and (101) were taken from almost contiguous spots, and yet the former (99) assayed only 1 dwt. 15 grs. of gold per ton, while the latter (101) assayed 19 dwts. 14 grs. of gold and 4 ozs. 13 dwts. 2 grs. of silver per ton. Nos. (100) and (102) were further apart, but looked identical. No. (100) assayed 4 ozs. 6 dwts. 13 grs. of gold and 1 dwt. 15 grs. of silver per ton, while No. (102) did not even yield a trace of gold.

A to B—Plate XXII.—continues *E* to *A* to the north-north-west 66 feet.

The greater part of the section consists of a white kaolinic sinter, but near *B* portions of this are stained with iron oxide, and there is a layer of fine-grained running siliceous sand-sinter. A sample (106) of the latter assayed 8 dwts. 4 grs. of gold per ton. A sample (103) of white kaolinic sinter assayed 10 ozs. 4 dwts. 4 grs., and another (104) only 14 dwts. 16 grs., of gold per ton. Another (107), near *B*, assayed 8 dwts. 4 grs. of gold per ton. A sample (105) of the kaolinic sinter, stained red, assayed 6 dwts. 12 grs. of gold per ton.

B to C—Plate XXIII.—continues the preceding section for 66 feet to north-north-west.

Near *B*, and midway between *B* and the open cutting in the centre of the view, the kaolinic sinter is honeycombed with ramifying and sinuating tubes, a little over an eighth of an inch in diameter, and glazed in the interior, believed to be the work of a winged insect resembling a hornet. The identity and life-history of this animal would form a worthy study for the Rockhampton Natural History Society. Much as I should have liked to devote some time to it, my investigations did not go beyond establishing the fact that it stings shrewdly. The geological interest attached to this animal and its work lies in the fact that the tubes bored by it have been discovered, at various times in the course of the workings, in positions which the animal could not possibly reach from the *present* surface, and which were, presumably, at or near the surface when the insect was at work. The antiquity of the species, it may reasonably be inferred, goes back to the period when the auriferous deposit of Mount Morgan was in course of formation. Before leaving the subject, I may say that Mr. John Dalley, overseer at the mine, drew my attention to the insect at work, and will no doubt be pleased to point it out to any naturalist.

A sample (109) of this honeycombed sinter, at *B*, assayed 1 dwt. 15 grs. of gold per ton. Another (110), between *B* and the open cutting, assayed 1 oz. 9 dwts. 9 grs. of gold per ton. A sample (112) of loose white siliceous sinter-sand from the south-south-east side of the cutting assayed 5 ozs. 1 dwt. 16 grs. of gold per ton. Another (108), from the layer of similar sinter-sand near *B*, assayed 8 dwts. 4 grs. of gold per ton. A sample (113) of yellow nodular kaolinic sinter from the north-north-west side of the cutting assayed 1 oz. 19 dwts. 4 grs. of gold per ton. A sample (114) of white kaolinic sinter, near *C*, assayed 6 dwts. 12 grs. of gold per ton. A sample (111) of ironstone near the open cutting assayed 11 dwts. 10 grs. of gold and 17 dwts. 23 grs. of silver per ton.

C to D—

C to D—Plate XXIV.—continues the face above the Lady Musgrave Bench for 66 feet north-west to the place where the bench is cut off by the fall of the hill. The whole of this face is of white kaolinic sinter similar to that in the preceding section.

In the foreground is the face between the Lady Musgrave Bench and the Lion's Den Bench 27 feet beneath. The greater part of this face is composed of white kaolinic sinter similar to that in the Lady Musgrave face, but the south-eastern end shows the ironstone which is traced round to Section *H* to *I* (already described). This ironstone came up to the original surface, and was for a time known as the Lady Musgrave Lode. A fragment of it can be seen in Section *B* to *C*, south-south-east of the open cutting. Two samples of the ironstone, as seen in Section *C* to *D*, were assayed. No. (115) gave 2 ozs. 9 dwts. of gold per ton; No. (138), consisting of drillings from the point where the man is seen in the view, assayed 4 ozs. 18 dwts. of gold per ton.

Two samples of the white kaolinic sinter assayed—No. (116), 8 dwts. 4 grs., and No. (117), 3 dwts. 6 grs., of gold per ton.

UNDERGROUND WORKINGS.

Some of the tunnels have been described in previous reports, but many important additions to the underground workings have been made since the date of the last. Descriptions of such as are new will be found below, commencing with those on the uppermost levels. It may be necessary to explain that the gaps in the sections represent places where from the presence of timbering or the begrimed condition of the tunnel I failed to make out the nature of the rock.

LADY MUSGRAVE TUNNEL.

This tunnel cut right across the eastern portion of the Mount on a north and south course. The excavation of the Lady Musgrave Bench down to the level of the tunnel has, however, reduced the latter to less than half its original length. The southern portion still remains, but will probably soon be opened up to the light of day. The following is the section, commencing at the south end:—

On east side of mouth, and for 5 *feet in.*—Siliceous kaolin, becoming ferruginous at mouth.

From 5 *to* 8 *feet in.*—Decomposed felstone dyke.

From 8 *to* 25 *feet in.*—White siliceous sinter, sometimes kaolinic and sometimes ferruginous.

From 25 *to* 31 *feet in.*—Incoherent white siliceous sinter, said to average 15 or 16 dwts. of gold per ton. A sample (1) assayed 6 dwts. 12 grs.

From 31 *to* 49 *feet in.*—Hard porous fine white sinter, sometimes coloured reddish by iron oxide, with a sort of bedding dipping north at 15 degrees.

From 66 *to* 74 *feet in.*—Fine, generally hard and compact sinter, sometimes mixed with ferruginous earth.

From 74 *to* 103 *feet in* (*at level of floor*).—Very fine soft siliceous sinter with a small proportion of kaolin, dipping at 40 degrees to the north.

From 103 *feet to north end.*—Ironstone with large boulders, sometimes stalactitic, surfaces at times having a fine play of colours. Some of this ironstone in the Lady Musgrave Bench on the east side of the tunnel contains visible gold.

NO. 2 TUNNEL.

This tunnel, on the level of the Lady Musgrave Bench and Tunnel, or a very few feet lower, crosses the Mount from side to side a little to the west of the Crown Shaft. It is thus described in the Second Report:—

"For a distance of about 120 feet from the south end the tunnel cuts through the 'deposit' (using the term as distinct from 'country-rock'). The deposit may be described as a porous siliceous material, sometimes a good deal iron-stained, and sometimes occurring in boulders which are enveloped in red ferruginous coats. The ferruginous material occurs also in veins and 'vughs.' At 120 feet the felstone dyke, so often alluded to, crosses the tunnel. Near the dyke the siliceous deposit gives off an efflorescence of alum, and in a few places it contains free hydrochloric acid. I was informed by Mr. Lisle that 30 feet from the south end of the tunnel an assay of red ferruginous material gave 17 ozs. of gold to the ton, and colours were obtained from that point to the south end. The auriferous deposit is thus proved to extend down the hill (in the line of No. 2 Tunnel), from the edge of No. 2 Floor to the mouth of the tunnel. The felstone dyke as seen in No. 2 Tunnel is about 26 feet wide, and sends off one vertical vein to north-north-east and another to south-south-west.

"From the dyke northward for 210 feet the tunnel intersects a light siliceous sinter with occasional ferruginous 'vughs' and veins, and (especially near the felstone dyke) stringy veins of felstone, probably emanating from the dyke. At the north end the sinter, although not by any means bedded, has a sort of arrangement suggestive of a dip to the south. A mass of felstone occupies the northmost 130 feet of the tunnel. Between this and the felstone dyke already referred to, the sinter contains a little gold all the way. No. 2 Tunnel is more or less auriferous in its whole length, except where the siliceous deposit is interrupted by felstone dykes. A short branch tunnel to the south-east connects the main tunnel with No. 5 Floor opposite the end of the wire tramway loading-shed, and runs mainly along the course of the felstone dyke."

The Eastern Branch of No. 2 Tunnel has already been alluded to in the description of the No. 4 Bench.

NO. 5 TUNNEL.

This tunnel is about 14 feet below the level of the Lady Musgrave, and runs quite across the Mount on a course about 30 degrees east of north. Commencing at the south end the section is:—

For 1 *foot in.*—Siliceous sinter.

From 1 *foot to* 22 *feet in.*—Yellow half-decomposed felstone (the "kaolin dyke" of the First Report).

From

From 22 *to* 38 *feet in.*—Spongy cellular siliceous sinter with cavities containing quartz crystals. The sinter is yellow in places, and especially near the felstone dyke the yellow is very like that of lead oxide. A specimen (2) from this place, however, contained no lead, but assayed 6 dwts. 12 grs. of gold per ton. A specimen (3) at 30 feet from the mouth of the tunnel assayed 11 dwts. 10 grs. of gold and 1 dwt. 15 grs. of silver per ton.

From 38 *to* 59 *feet in.*—White and occasionally yellow sinter. A soft white kaolin (decomposed felstone dyke) comes in at 53 feet on the roof, where it is 4 feet thick and comes down to the floor as a mere seam at 59 feet.

From 74 *to* 86 *feet in.*—Decomposed felstone dyke.

From 86 *to* 114 *feet in.*—White sinter. A sample (4) from 89 feet assayed 1 dwt. 15 grs. of gold per ton.

From 114 *to* 132 *feet in.*—Sinter. Irregular masses of earthy, ferruginous, and kaolinic sinter alternate with layers of white kaolinic sinter. A rude sort of bedding is nearly horizontal, but there is a slight dip to the south-east.

At 132 *feet in.*—Earthy ferruginous sinter rests, 2 feet above the floor, on white kaolinic sinter. A sample (5) of the earthy ferruginous sinter, 5 feet above the floor, assayed 8 dwts. 4 grs. of gold and 1 dwt. 15 grs. of silver per ton. A sample (6) of the white kaolinic sinter below assayed 6 dwts. 12 grs. of gold per ton.

From 132 *to* 181 *feet in.*—Kaolinic sinter. The bedding is rudely horizontal, but near 181 feet there is an arch or anticline.

At 181 *feet in.*—Earthy red ironstone.

At 207 *feet in.*—Siliceous iron sand, loose and dry. It ran in like a sandhill from the sides of the tunnel, and was stopped with great difficulty. A sample (7) from 5 feet above the floor assayed 1 dwt. 15 grs., and another (8), from the floor, assayed 6 dwts. 12 grs., of gold per ton.

From 207 *to* 240 *feet in.*—Kaolinic sinter with irregular bands of ferruginous sinter and ironstone, rising to the north. At 240 feet is the beginning of No. 5 Crosscut, which goes eastward to the hillside, and a winze communicating with the Freehold Tunnel beneath. Opposite the mouth of the crosscut there are about three feet of soft blood-red ironstone near the roof, and sinter on the floor. A sample (9) of the former assayed 4 dwts. 21 grs., and a sample (10) of the latter assayed 3 dwts. 6 grs., of gold per ton.

From 240 *to* 264 *feet in.*—Alternating irregular layers of ironstone and kaolinic sinter, rising to the north-east. At 264 feet the layers are nearly horizontal. Samples from 264 feet assayed—No. (11) (ironstone from four feet above the floor), 4 dwts. 4 grs., and No. (12) (kaolinic sinter from near the floor), 1 dwt. 15 grs., of gold per ton.

From 264 *to* 353 *feet in.*—Alternating layers of siliceous sinter, some more and some less kaolinic, with red ferruginous sinter. Two specimens—(13) and (14)—of kaolinic sinter, from 286 and 353 feet respectively, each assayed 1 dwt. 15 grs. of gold per ton.

From 353 *to* 387 *feet in.*—At 364 feet is the shaft by which ore for treatment is shot down to No. 5 Tunnel from the Lion's Den Bench. About this point the last is seen of the red sinter. Kaolinic sinter continues to 387 feet, where it becomes looser and more friable, probably containing less kaolin. A specimen (15) from 387 feet assayed 14 dwts. 17 grs. of gold and 4 dwts. 21 grs. of silver per ton.

From 387 *to* 430 *feet in.*—The sinter here is rather more kaolinic than before, so that at times it is difficult to distinguish it from a decomposing felstone such as the dykes are made of. At 430 feet the sinter is yellow. An assay from this place (16) gave 3 dwts. 6 grs. of gold per ton.

From 430 *feet to north end of Tunnel* (470 *feet*).—Yellow felstone.

NO. 5 CROSSCUT.

This crosscut is driven west from the hillside and meets the No. 5 Tunnel at the point already noted. Commencing at the east end, the section is :—

Open cutting at mouth.—Quartz porphyry—blebs of quartz in a matrix of reddish decomposing felstone; 30 feet across.

From 6 *to* 43 *feet in.*—Soft decomposing argillaceous shales. Nearly vertical. Strike, north and south. Interrupted occasionally by bands of hard quartzite, very pyritous, and by veins of quartz and ironstone. The whole efflorescing alum.

From 43 *to* 52 *feet in.*—Dolerite dyke running north-west and south-east.

From 52 *to* 73 *feet in.*—Kaolin, a dyke or sheet, running west-south-west.

From 73 *to* 93 *feet in.*—Decomposed argillaceous shales and greywackes, with a few bands of quartzite.

From 93 *to* 106 *feet in.*—The same, with masses of ironstone (stalactitic) in "vughs" in the roof. A specimen of this ironstone (17) assayed 3 dwts. 6 grs. of gold per ton.

From 106 *to* 123 *feet in.*—Decomposed felstone dyke. Nearly vertical, but underlying a little to the west. A little ironstone on western side.

From 123 *to* 165 *feet in.*—Kaolinic sinter or decomposed argillaceous shales (?). There is a sort of rude bedding dipping at a low angle to the west. A sample (18) from 145 feet in assayed 1 dwt. 15 grs. of gold per ton. At 165 feet is the shaft or pass by which the Lady Musgrave Bench is put in communication with No. 5 Crosscut. In the crosscut, at this pass, there are some nests of purer siliceous sinter in the midst of the kaolinic sinter. A specimen (19) of one of these assayed 6 dwts. 12 grs. of gold and 2 ozs. 5 dwts. 17 grs. of silver per ton.

From 165 *to* 212 *feet in.*—Kaolinic sinter without much siliceous grit. A specimen (20) from 178 feet assayed 4 dwts. 21 grs. of gold per ton. Another (21), from 192 feet, assayed 2 ozs. 2 dwts. 11 grs. of gold and 3 dwts. 6 grs. of silver per ton. A third (22), from 210 feet, assayed 2 ozs. 5 dwts. 17 grs. of gold and 4 dwts. 21 grs. of silver per ton.

From 212 *feet to Main Tunnel.*—Kaolinic sinter with pockets and nests of purer siliceous sinter. The sinter is intersected with nearly horizontal intrusive sheets of decomposing felstone. A sample (23) of siliceous sinter from 238 feet assayed 3 dwts. 6 grs. of gold per ton. Another (24), of siliceous sinter from 292 feet, assayed 14 dwts. 17 grs. of gold and 1 dwt. 15 grs. of silver per ton.

NO. 5A TUNNEL.

This tunnel crosses the Mount nearly from north to south, passing by the Crown Shaft or Main Pass, on the same level as No. 5 Tunnel. It gives the following section, commencing at the south end:—

From Mouth of Tunnel to 25 *feet in.*—Siliceous sinter stained with red and yellow iron oxide. At 25 feet a dyke of felstone is met with. On the south side of the dyke is some kaolinic sinter in layers which dip to the south. The ground is stoped up for about eight feet above the tunnel on the south side of the dyke. A sample (25) from a pocket of loose white siliceous sand, 14 feet in, assayed 1 oz. 9 dwts. 9 grs. of gold and 4 dwts 21 grs. of silver per ton. A sample (26) of kaolinic sinter on the edge of the dyke assayed 11 dwts. 10 grs. of gold per ton and a trace of silver. A sample (27) of compact siliceous sinter on the edge of the dyke assayed 3 dwts. 6 grs. of gold per ton.

From 25 *to* 57 *feet in.*—Felstone dyke. (In its more decomposed condition this dyke was referred to in my First Report as *the* Kaolin Dyke.) In the tunnel it is a bright sulphur-yellow in colour.

From 57 *feet in to Crown Shaft* (264 *feet in*).—Spongy cellular siliceous sinter, rarely containing much kaolin; lumpy and nodular. At 154 feet the sinter is intersected by a felstone dyke, two to four feet wide, running south-east. Samples from this section of the tunnel assayed as follows:—

	dwts.	grs.	
(29) From 66 feet	4	21	gold per ton
(30) From 104 feet	3	6	„ „
(32) From 144 feet	6	12	„ „
(33) From 180 feet	3	6	„ „
(34) From 221 feet	3	6	„ „
(35) From 242 feet	1	15	„ „

For 219 *feet north of Crown Shaft.*—Cellular spongy siliceous sinter, sometimes more compact and outwardly resembling quartz, but always light and evidently porous. Eighty feet north of the shaft the sinter is interrupted by a dyke, 15 feet wide, of (decomposed) felstone with (decomposed) felspar crystals. On the north side of the dyke is a vein of siliceous sinter with soft red ironstone. Two chains north of the shaft a dyke of felstone, two feet wide, crosses the tunnel at right angles. Samples of the sinter from this portion of the tunnel assayed as follows:—

	dwts.	grs.	
(36) From 25 feet north of shaft	4	21	gold per ton
(37) From 52 feet north of shaft	3	6	„ „
(38) From 96 feet north of shaft	6	12	„ „
(39) From 125 feet north of shaft (ferruginous siliceous sinter) ...	3	6	„ „
(40) From 182 feet north of shaft (ferruginous siliceous sinter) ...	1	15	„ „
(41) From 214 feet north of shaft (very open spongy sinter)	1	15	„ „

From 219 *feet north of Crown Shaft to north end of Tunnel.*—Felstone dyke.

HOPPER TUNNEL.

This tunnel is driven 20 degrees north of west from the south-east side of the hill. Near its inner end it is met at right angles by what is known as the Hopper Crosscut, in reality a much longer tunnel driven from the northern side of the hill. The section of the Hopper Tunnel itself is as follows, commencing at the east end:—

For 36 *feet in.*—Decomposed greywackes, shales, and quartzites.

From 36 *to* 89 *feet in.*—Dyke of altered quartz-porphyry. The quartz-porphyry has kaolinic sinter mixed up with it as far as 84 feet, and from 84 to 89 feet has ironstone mixed up with it.

From 89 *to* 119 *feet in.*—Decomposing yellow felstone dyke running west-south-west.

Above the tunnel the ground is stoped out to the north, or nearly at right angles to the line of the tunnel, for a width of 45 feet.

From 119 *to* 182 *feet in.*—The ground is all stoped out. The side of the stope on the level of the tunnel, and about 10 feet south of it, is timbered. Work is being carried on at 182 feet on the level of the tunnel along a face extending from south to north for 63 feet. This face for the first 48 feet to the north shows kaolinic sinter, white, with streaks of red, and for the remainder of the distance coarse-grained siliceous sinter. Samples from this face assayed as follows:—

	Gold. Ozs.	dwts.	grs.		Silver. Ozs.	dwts.	grs.	
(43) 9 feet from south end	1	4	12	...	0	1	15	per ton
(44) 25 „ „	1	15	22	...	0	6	12	„
(45) 48 „ „	0	6	12					
(46) 63 „ „	0	4	21	...	0	3	6	„

The north face of the stopes at the level of the tunnel shows kaolinic sinter. The stope narrows upward till it comes to a point 31 feet above the tunnel, where it has just been connected with the surface by a new shaft coming out below the tramway from the No. 4 Bench to the Hopper.

The following assays are of samples taken from the western face of the stopes 20 feet above the level of the tunnel. The stopes are here narrower than below, so that the face is only 12 feet west of the crosscut (see Map No. 2):—

	Gold. Ozs.	dwts.	grs.		Silver. Ozs.	dwts.	grs.	
(47) At south end	0	3	6	per ton				
(48) 12 feet from south end	0	3	6	„				
(49) 20 „ „	0	6	12	„				
(50) 40 „ „	14	14	4	...	0	3	6	per ton
(51) 56 „ „	0	6	12	...	0	1	15	„

HOPPER CROSSCUT.

The following is the section exposed by this crosscut, beginning at its southern end, where it strikes off at right angles to the Hopper Tunnel:—

First 76 *feet north.*—Stopes and timbered portion of crosscut.

From 76 *to* 132 *feet out.*—Kaolinic sinter mixed with purer siliceous sinter. A sample (52) from 113 feet assayed 4 dwts. 21 grs. of gold and 6 dwts. 12 grs. of silver per ton. Another (53), from 132 feet, assayed 3 dwts. 6 grs. of gold and 8 dwts. 4 grs. of silver per ton.

From 132 *to* 180 *feet out.*—Dyke of decomposing felspar-porphyry from 132 to 134 feet, underlying at 45 degrees to the north. Thence to 180 feet kaolinic sinter mixed with masses of purer siliceous sinter. A sample (54) from 177 feet assayed 3 dwts. 6 grs. of gold per ton.

From 180 *to* 192 *feet out.*—Dyke of decomposing felspar-porphyry.

From

From 192 *to* 274 *feet out.*—Highly kaolinic sinter with irregular red lines, which have a sort of rough dip to the south. The following samples were assayed:—

		Gold. Ozs.	dwts.	grs.		Silver. Ozs.	dwts.	grs.	
(55) A red portion, from 198 feet	...	1	1	6	...	21	1	9	per ton
(56) White kaolin, from 226 feet	...	3	0	6	...	0	6	12	„
(57) White kaolin, from 264 feet	...	0	3	6	per ton.				

From 274 *to* 330 *feet out.*—Kaolinic sinter, mixed with more siliceous sinter, and intersected by several small felstone dykes. A sample (58) of hard kaolin from 312 feet assayed 1 dwt. 15 grs. of gold per ton. At 289 feet a pass comes down to the crosscut.

From 330 *to* 348 *feet out.*—Decomposing yellow felstone dyke, underlying to the south.

From 348 *to* 396 *feet out.*—Kaolinic sinter, with occasional ferruginous patches.

From 396 *to* 402 *feet out.*—Yellow felstone dyke.

From 402 *feet out to mouth of tunnel* (452 *feet*).—Stiff clay. Decomposing felstone?

FREEHOLD TUNNEL.

This tunnel remains as it was described in my Second Report in the following terms:—

"The Freehold Tunnel . . . . . is driven W. 30° N. for a distance of 789 feet till it strikes the Main Shaft 206½ feet below No. 2 Floor, and 122½ below the level of No. 2 Tunnel. For the first 180 feet the tunnel traverses a decomposing felspathic crystalline rock. . . . . The next 40 feet are in compact, massive, pyritous quartzite. The next 80 feet are in dolerite. To this succeed 30 feet of a decomposing basic crystalline rock (dolerite), 20 feet of decomposed felspathic red and black ferruginous rock (dolerite), which exudes sulphate of magnesia, and 42 feet of decomposing felspathic yellow rock (dolerite*). Beyond this point (392 feet from the mouth of the tunnel) and on to the Main Shaft the tunnel intersects (with the exception of a felstone dyke 482 feet from its mouth) fine light siliceous sinter, impregnated in places with brown hydrous iron oxide. For the first 11 feet the sinter assayed for 7 ozs. 6 dwts. of gold per ton. Gold continued for 49 feet further, but was not so rich. At 525 feet from the mouth, about 8 feet of the sinter in the floor of the tunnel assayed for 6 ozs. of gold to the ton. From this point to the shaft Mr. Lisle says there was no free gold. A little pyrites can be saved in the dish on washing the sinter.

"From the main shaft, a southern crosscut runs 237 feet from the main Freehold Tunnel in a south-south-west direction. It is connected at the south end with a shaft 122½ feet up to No. 5 Floor and 33 feet down to No. 1 Tunnel. For 138 feet from the main shaft an exceedingly light, soft, white siliceous sinter, without gold, is traversed by the tunnel; then a narrow felspar [felstone] dyke is crossed, underlying to the south. After 48 feet of rather compact silica the felstone dyke which bounds the auriferous deposit on the south-west side in No. 2 Floor is again met with; it is here 19 feet wide, and forms the limit of the sinter. Between it and the south end of the tunnel only the quartzite of the country-rock is seen."

FREEHOLD (EASTERN) CROSSCUT.

This crosscut is driven from the southern side of the Mount on a bearing of about north 28 degrees east. It intersects the Freehold Tunnel about 390 feet from the mouth of the latter, and is carried beyond it for 46 feet. The following is the section of the crosscut, commencing at the mouth:—

For 83 *feet in.*—Quartzite and felspathic greywackes and shales, intersected by decomposed felstone dykes. The whole of the rocks are so much decomposed that it is practically impossible to separate the sedimentary from the intrusive.

From 83 *to* 87 *feet in.*—Decomposed felstone, with a spherulitic structure.

From 87 *to* 101 *feet in.*—Quartzites, greywackes, and shales.

From 101 *to* 112 *feet in.*—Kaolinic sinter. The junction of the sinter with the sedimentary rocks, at 101 feet, is nearly vertical. A sample (59) of sinter from 101 feet assayed 4 dwts. 21 grs. of gold per ton. Another (60) from 112 feet assayed 3 dwts. 6 grs. of gold per ton.

From 112 *to* 171 *feet in.*—Kaolinic sinter alternating with hard siliceous bands, which have a slight dip to the north. A sample (61) from 132 feet assayed 1 dwt. 15 grs. of gold per ton. Another (62), from 166 feet, assayed 14 dwts. 17 grs. of gold and 3 dwts. 6 grs. of silver per ton.

From 171 *to* 189 *feet in.*—Tough yellow decomposed felstone dyke. (*The* "Kaolin Dyke" of First Report.)

From 189 *to* 220 *feet in.*—Kaolinic sinter. At 204 feet a shaft comes down from the surface to the crosscut and down 48 feet further to the Freehold Stopes.† A sample (63) from 198 feet assayed 7 ozs. 2 dwts. 2 grs. of gold and 3 dwts. 6 grs. of silver per ton. Another (64), from 220 feet, assayed 2 ozs. 12 dwts. 6 grs. of gold and 4 dwts. 21 grs. of silver per ton.

From 220 *to* 249 *feet in.*—White and brown kaolinic sinter. A specimen (65) from 249 feet assayed 2 ozs. 10 dwts. 15 grs. of gold and 3 dwts. 6 grs. of silver per ton.

From 249 *to* 284 *feet in.*—Kaolinic sinter mixed with bluish siliceous sinter. The latter is generally in roundish boulders or lenticular patches. There is a sort of rough dip to the south. A specimen (66) from 264 feet assayed 8 dwts. 4 grs. of gold and 6 dwts. 12 grs. of silver per ton. At 284 feet is the Freehold Crosscut Drive, which branches off right and left at right angles to the crosscut itself. At the mouth of the drive a specimen (67) was taken which assayed 13 dwts. 1 gr. of gold and 4 dwts. 21 grs. of silver per ton.

From 284 *to* 323 *feet in.*—Similar sinter to the last described (249 to 284 feet), but becoming more siliceous. A sample (68) from 323 feet assayed 19 dwts. 14 grs. of gold and 3 dwts. 21 grs. of silver per ton. At this point is No. 1 Winze, connecting the crosscut with the Grasstree Tunnel beneath.

From 323 *to* 342 *feet in.*—Siliceous sinter mixed with kaolin.

From 342 *to* 349 *feet in.*—Dyke of decomposed felspar-porphyry (?).

From 349 *to* 378 *feet in.*—Siliceous sinter with a little kaolin. A specimen (69) from 378 feet assayed 3 dwts. 6 grs. of gold per ton.

From 378 *feet to* 396 *feet in.*—Siliceous sinter with a little kaolin.

From 396 *to* 416 *feet in.*—Felstone dyke underlying to north, and containing pockets of siliceous sinter. At 416 feet the crosscut intersects the Freehold Tunnel. *From*

* The word in parentheses ought to have been "felstone." † Now (June, 1892), down to the Grasstree Tunnel.

From the intersection of the Freehold Tunnel to the face (46 *feet*).—In the southern end of this section is siliceous sinter, with ironstone and a little kaolin; in the north end the sinter is for the most part kaolinic. A sample (70), from the northern face, assayed 14 dwts. 17 grs. of gold per ton and a trace of silver.

STOPES BELOW FREEHOLD CROSSCUT.

These stopes have already been referred to in describing the Freehold Crosscut (204 feet). The bottom of the stopes is 22 feet above the level of the Grasstree Tunnel.

On descending by the shaft for 38 feet from the Freehold Crosscut the bottom of the stopes is reached, and the northern face is found a short distance to the north. The bottom level of the stopes is for the most part timbered, so that little can be seen. The stope generally shows siliceous sinter, a little kaolinic sinter, and a good deal of ironstone, with numerous felstone dykes. A specimen (80) of ironstone above a nearly horizontal felstone dyke, from the eastern face of the stope, 14 feet up, and 33 feet north of No. 2 Winze, assayed 6 dwts. 12 grs. of gold and 9 dwts. 19 grs. of silver per ton. A second specimen (81), decomposing ironstone mixed with specks of decomposing felspar, from the same level, and 17 feet north of the preceding, assayed 1 oz. 7 dwts. 18 grs. of gold and 3 dwts. 6 grs. of silver per ton. A third (82), from the same level, at the shaft by which we descended, assayed 4 dwts. 21 grs. of gold per ton.

FREEHOLD DRIVE.

This drive, as has already been mentioned, is at right angles to the course of the Freehold Crosscut. It has been carried 148 feet west, 28 degrees north, and 86 feet east, 28 degrees south of the Crosscut.

EASTERN DRIVE.

First 26 *feet from Crosscut.*—Kaolinic sinter, and with blocks of more siliceous sinter.

From 26 *to* 54 *feet.*—Ironstone, mixed with a little kaolinic sinter. Bands dipping south at 45 degrees. A sample (71) of ironstone from 40 feet assayed 1 dwt. 15 grs. of gold per ton.

From 54 *to* 57 *feet.*—Dyke of kaolin (decomposed felstone).

From 57 *to* 86 *feet.*—Serpentine, greywacke, and quartzite, all very pyritous and much broken.

WESTERN DRIVE.

First 81 *feet from Crosscut.*—Siliceous sinter with dabs, blotches, veins, and pipes of kaolinic sinter. Slight dip to east. A sample (72) at 7 feet assayed 8 dwts. 4 grs. of gold and 3 dwts. 6 grs. of silver per ton. Another (73), at 26 feet, assayed 13 dwts. 1 gr. of gold per ton and a trace of silver. A third (74), from 66 feet, assayed only a trace of gold.

From 81 *to* 91 *feet.*—Decomposing felstone dyke.

From 91 *to* 148 *feet.*—Siliceous sinter, the first half somewhat ferruginous, all dipping to east. At the face are about two feet of white kaolinic sinter streaked with red. A sample (75) of ferruginous sinter from 94 feet assayed 1 dwt. 15 grs. of gold per ton. A second (76), from 112 feet, gave only a minute trace of gold. A third (77), of red kaolinic sinter from the roof at 127 feet, gave a trace of gold. A fourth (78), of red and white banded kaolinic sinter from the face at 148 feet, assayed 3 dwts. 6 grs. of gold per ton. A fifth (79), of ferruginous sinter from the face above the preceding sample, assayed 6 dwts. 12 grs. of gold and 3 dwts. 6 grs. of silver per ton.

FREEHOLD WESTERN CROSSCUT.

This Crosscut is described in the Second Report as follows:—

"From the main shaft a southern crosscut runs 237 feet from the Main Freehold Tunnel in a south-south-west direction (*see* Section G). It is connected at the south end with a shaft 122½ feet up to No. 5 Floor, and 33 feet down to No. 1 Tunnel. For 138 feet from the main shaft an exceedingly light soft white siliceous sinter without gold is traversed by the tunnel; then a narrow felspar [felstone] dyke is crossed underlying to the south. After 48 feet of rather compact silica, the felstone dyke which bounds the auriferous deposit on the south-west side in No. 2 Floor is again met with; it is here 19 feet wide, and forms the limit of the sinter. Between it and the south end of the tunnel only the quartzite of the country-rock is seen."

NO. 1 TUNNEL.

From the description of this tunnel in my Second Report it will be seen that the tunnel traversed country-rock throughout its whole length, with the exception of "twenty-five feet of silica brown with iron oxide, which assayed 3 ozs. gold and 3 ozs. silver per ton."*

CROSSCUT WEST OF NO. 1 TUNNEL.

First 37 *feet from Tunnel.*—Kaolin (decomposed felstone dyke) full of fine pyrites, and copper-stained. It is interesting to note that the copper-stains have made their appearance since my former visit to the crosscut in the latter end of 1889, thus throwing some light on the rate at which copper pyrites may, under favourable conditions, be converted into sulphate of copper.

From 37 *feet to face.*—Country-rock of quartzite, shale, and greywacke, intersected by numerous reefs of quartz and dykes of dolerite and felstone. All the above rocks, with the exception of the last-named, are charged with pyrites and arsenical pyrites to such an extent that these minerals often form the greater proportion of the mass. A specimen (85) from 147 feet assayed 4 dwts. 21 grs. of gold per ton. This was the spot from which Mr. Dunn's assay No. 28 (a trace of gold) was taken. A second specimen (84), from 171 feet, assayed 6 dwts. 12 grs. of gold per ton. This was the spot from which Mr. Dunn's assay No. 36 (a trace of gold) was taken. A third sample (83), from 228 feet, assayed 3 dwts. 6 grs. of gold per ton.

GRASSTREE TUNNEL.

This tunnel is driven from the side of the Mount, on a course of about west 40 degrees north, towards the Crown Shaft. It is 35 feet below the level of No. 1 Tunnel and 21 above the Sunbeam level. The following is the section, commencing at the mouth, in Grasstree Gully:—

For 154 *feet in.*—Greywackes, shales, and quartzites, intersected by several dolerite dykes.

From 154 *to* 236 *feet in.*—Similar rocks, heavily charged with pyrites.

From 236 *to* 277 *feet in.*—Serpentine containing a good deal of pyrites, and said to be auriferous. A sample (86) from 277 feet assayed 8 dwts. 4 grs. of gold and 1 dwt. 15 grs. of silver per ton.

From

* In Section H attached to the Second Report (which I had no opportunity of revising) this assay is erroneously stated to be "6 ozs. per ton," presumably of gold.

From 281 *to* 286 *feet in.*—Two dolerite dykes each two feet wide, one foot apart.

From 286 *to* 287 *feet in.*—Serpentine.

From 287 *to* 301 *feet in.*—Dolerite.

From 301 *to* 306 *feet in.*—Solid pyrites. A sample (87) assayed 3 dwts. 6 grs. of gold per ton.

From 306 *to* 322 *feet in.*—Dolerite.

From 322 *to* 382 *feet in.*—Almost solid pyrites, including arsenical and copper pyrites. At 382 feet there is a good deal of quartz in the pyrites.

From 382 *to* 412 *feet in.*—Nearly solid pyrites.

From 412 *to* 415 *feet in.*—Decomposing yellow felstone dyke, underlying at a steep angle to the north-west. About one foot of pyrites on the hanging-wall side.

From 415 *to* 429 *feet in.*—Kaolinic sinter, with streaks of decomposed pyrites dipping north-west. A sample (88) gave a trace of gold on assay. At 429 feet is the No. 1 Winze from the Grasstree Tunnel up to the stopes below the Freehold Crosscut.

From 435 *to* 460 *feet in.*—Soft quartzose and felspathic rock, heavily charged with pyrites.

From 460 *to* 463 *feet in.*—Decomposing felstone. At 463 feet the tunnel is intersected by the Grasstree Crosscut.

From 463 *to* 506 *feet in.*—Quartzose and felspathic rock heavily charged with pyrites.

From 506 *to* 527 *feet in.*—Decomposing rock of quartz and felspar particles.

From 527 *to* 548 *feet in.*—Coarse-grained siliceous sinter.

From 548 *to* 582 *feet in.*—Siliceous sinter. A specimen (89) from 560 feet assayed 3 dwts. 6 grs. of gold per ton.

From 582 *to* 585 *feet in.*—Decomposing felstone dyke.

From 585 *to* 617 *feet in.*—Siliceous sinter, coarse-grained, hard and compact in places. At 617 feet the sinter was loose and running.

From 617 *to* 662 *feet in.*—Siliceous sinter, hard, compact, bluish.

From 662 *to* 690 *feet in.*—Hard kaolinic sinter or decomposed felstone.

From 690 *to* 724 *feet in.*—Decomposing grey felstone.

From 724 *to* 736 *feet in.*—Solid pyrites. A specimen (90) from 736 feet gave a trace of gold. This point is the present face of the tunnel, and is estimated to be about 100 feet from the Crown Shaft.

GRASSTREE CROSSCUT.

This Crosscut runs right and left from the Grasstree Tunnel, 463 feet from the mouth of the latter, nearly at right angles. It is carried for 114 feet north-east and 129 feet south-west of the tunnel.

The North Crosscut gives the following section, commencing at the tunnel:—

First 19 *feet.*—Timbered.

From 19 *to* 54 *feet.*—Decomposed felspathic and siliceous rock.

From 54 *to* 63 *feet.*—Kaolinic sinter. A sample (91) assayed 4 dwts. 21 grs. of gold per ton.

From 63 *to* 114 *feet* (*face*).—Nearly solid pyrites, with silica. A specimen (92) of this from 82 feet assayed 1 dwt. 15 grs. of gold per ton. On the eastern side of the face is a quartz reef heavily charged with pyrites, and underlying to the north-west. A sample (93) from this reef only yielded a trace of gold.

The South Crosscut gives the following section, commencing at the tunnel:—

First 84 *feet.*—Quartzose and felspathic rock heavily charged with pyrites. A specimen (94) of nearly solid pyrites from 73 feet gave no gold on assay.

From 84 *to* 96 *feet.*—Yellow decomposing felstone. At 96 feet the Grasstree Drive leaves the crosscut at right angles.

From 96 *to* 129 *feet* (*face*).—Yellow felstone, becoming less decomposed towards face.

GRASSTREE DRIVE.

First 4 *feet from Crosscut.*—Yellow felstone.

From 4 *to* 31 *feet.*—Sinter, siliceous and kaolinic, sometimes one element and sometimes the other predominating. A sample (95) from 11 feet, in which the kaolinic material predominated, assayed 4 dwts. 21 grs. of gold per ton. Another (96), from 31 feet, in which the siliceous predominated, assayed 17 dwts. 23 grs. of gold and 3 ozs. 6 dwts. 23 grs. of silver per ton.

From 31 *to* 35 *feet.*—Brown and yellow kaolinic sinter. At 35 feet a rise or stope of about 15 feet has been made above the tunnel.

From 35 *to* 66 *feet.*—Alternating kaolinic, felspathic, and pyritous rock (sinter?) with a rude dip to the south-east. A specimen (97) at 66 feet assayed 1 oz. 12 dwts. 16 grs. of gold and 1 oz. 14 dwts. 7 grs. of silver per ton.

From 66 *to* 89 *feet* (*face*).—At 66 feet a mass of decomposed pyrites rises from the floor of the drive, reaches the roof, and descends to the floor at 85 feet. At 85 feet it is succeeded by kaolinic sinter, with hard yellow blotches and patches of siliceous sinter. A specimen (98) from the face assayed 4 dwts. 21 grs. of gold per ton.

SUNBEAM TUNNEL.

This tunnel runs from the hillside in Hall's Gully north-eastward to the Crown Shaft, and communicates midway with the overlying No. 1 Crosscut by the Lady Brassey Shaft. At the Lady Brassey Shaft is quartzite and serpentinous schist. Thence to the Crown Shaft the tunnel mostly shows quartzite, which is always rather and occasionally highly pyritous, especially on the south-east side. There is, however, nothing like the masses of pyrites in the No. 1 Tunnel. The pyritous quartzite is intersected by numerous felstone dykes. Near the Crown Shaft is a mass of pyritous quartz. I was informed that the Crown Shaft below the level of the tunnel was sunk through a highly pyritous rock.

Traversing the tunnel from the Lady Brassey Shaft towards the mouth a large dolerite dyke is met with a few yards from the shaft. There is another about 50 feet from the mouth of the tunnel, and another containing large felspar crystals about 150 feet from the mouth. The remainder of this portion of the tunnel is mainly in pyritous quartzite, with a few bands of shale and serpentinous schist.

RIP-AND-TEAR TUNNEL AND CROSSCUTS.

This tunnel is at a low level on the south side of the Mount, and at a considerable distance from the known auriferous deposit. The tunnel and crosscuts show nothing but country-rock, consisting of quartzites, greywackes, and shales, intersected by basic and acidic igneous dykes.

SUGARLOAF TUNNEL.

The Sugarloaf is a minor hill or spur of Mount Morgan, lying to the south-west. It is drained on the west and south by Mundic Creek and tributary gullies. From one of the latter, named Sugarloaf Gully, a tunnel has been driven through the hill north-north-westward, 89 feet below the level of the Sunbeam Tunnel. A shaft, known as the Main Sugarloaf Shaft, is being sunk near Hall's Gully north of the hilltop.

North of the shaft the tunnel for the first 12 feet shows ferruginous sinter. The remainder of the tunnel, to the northern face, is in pyritous quartzite and greywacke country-rock, with occasional quartz. The water level in the shaft was 18 feet above the tunnel.

Siliceous and ferruginous sinter is seen from a point about 40 feet south of the main shaft, and extends as far as the shaft near the top of the hill. The sinter is often compact and not easily distinguishable from quartz. The sinter at the hill shaft, and for a few yards beyond, contained some gold, but it is admitted that nothing payable has yet been met with in the tunnel. From this point to the mouth of the tunnel in Sugarloaf Gully there is nothing but country-rock, consisting of pyritous greywackes and quartzites, intersected by dolerite dykes.

The Main Sugarloaf Shaft is 440 feet deep, and is to be sunk to a total depth of 820 feet. At the bottom I saw quartzites and greywackes with irregular blotches of quartz and a good deal of pyrites, as well as some thin (vertical) felstone dykes and seams of kaolin (decomposed felstone?).

WESTERN AND ROAD TUNNELS.

These are short tunnels in the western portion of the ground, drained by Mundic Creek. Both are in country rock throughout. The Road Tunnel is 62 feet above the level of the Sugarloaf Tunnel, and 13 feet below the level of the Western. The latter is 14 feet below the Sunbeam level.

ASSAYS.

For convenience of reference, the above Assays are thrown into the form of a Table:—

Assay No.	Locality.	Character of Rock.	Gold per Ton.	Silver per Ton.
			Ozs. dwts. grs.	Ozs. dwts. grs.
		No. 4 Bench.		
139	I to J	Decomposed felspathic and siliceous	Trace.	...
140	Ditto	ditto	0 11 10	...
141	J to K	Ironstone	0 4 21	...
149	K to L	Yellow sinter	0 9 19	...
151	Ditto	Ironstone	0 1 15	...
142	Ditto	Yellow sinter	0 1 15	...
150	Ditto	Ironstone	0 8 4	...
143	Ditto	ditto	Trace.	...
147	Ditto	ditto	0 6 12	...
148	Ditto	ditto	0 9 19	...
144	Ditto	Siliceous sinter-sand	0 3 6	...
145	Ditto	ditto	0 13 1	...
146	Ditto	ditto	0 11 10	...
154	L to M	ditto	0 4 21	...
155	Ditto	ditto	0 1 15	...
156	Ditto	Ironstone	1 4 12	...
152	Ditto	Yellow sinter	17 4 15	...
153	Ditto	Ironstone	0 13 1	...
157	M to N	Mixed sinter and ironstone	0 16 8	...
158	Ditto	White sinter	0 6 12	...
160	At N	Ironstone	0 14 17	Trace.
159	Near N	Iron-stained sinter	3 11 20	...
161	South of N	Ironstone	11 16 20	0 3 6
162	O to P	Siliceous sinter	1 2 20	0 1 15
163	Ditto	Siliceous sinter, iron-stained	0 9 19	0 1 15
164	P to Q	Siliceous sinter	0 6 12	...
165	Ditto	Ironstone	0 3 6	...
167	Q to R	Siliceous sinter	0 4 21	...
168	Ditto	ditto	0 4 21	...
169	Ditto	ditto	0 3 6	...
170	Ditto	Ferruginous sinter	0 4 21	...
171	Ditto	ditto	1 2 20	0 1 15
166	Ditto	Siliceous sinter	0 6 12	...
172	S to T	ditto	0 3 6	...
173	Ditto	ditto	1 2 20	0 1 15
174	Ditto	White sinter	1 11 0	0 1 15
175	Ditto	Ferruginous sinter	1 19 4	0 3 6
176	Ditto	Sinter	1 9 9	0 1 15
177	Ditto	ditto	17 14 10	0 3 6
178	Ditto	ditto	3 11 20	0 1 15
		Lady Musgrave Bench.		
132	I to H	Ironstone	0 16 8	...
133	Ditto	ditto	0 6 12	...
134	Ditto	Iron-stained kaolinic sinter	5 14 8	...
135	Ditto	White kaolinic sinter	0 16 8	...
137	Ditto	ditto	0 4 21	...

ASSAYS—

ASSAYS—*continued.*

Assay No.	Locality.	Character o Rock.	Gold per Ton.	Silver per Ton.
			Ozs. dwts. grs.	Ozs. dwts. grs.
129	H to G	Ironstone	0 3 6	...
128	Ditto	Iron-stained siliceous sinter	Trace	...
131	Ditto	ditto	0 1 15	...
130	Ditto	Ironstone	0 1 15	...
127	G to F	ditto	0 14 16	...
124	Ditto	ditto	0 6 12	...
125	Ditto	Yellow siliceous sinter	0 8 4	...
123	Ditto	ditto	2 2 11	...
120	F to E	Ironstone	1 1 5	...
119	Ditto	Iron-stained kaolinic sinter	0 1 15	...
118	Ditto	ditto	0 3 6	...
99	E to A	White kaolinic sinter	0 1 15	...
101	Ditto	ditto	0 19 14	4 13 2
100	Ditto	ditto	4 6 13	0 1 15
102	Ditto	ditto	Nil.	...
106	A to B	Siliceous sand-sinter	0 8 4	...
103	Ditto	White kaolinic sinter	10 4 4	...
104	Ditto	ditto	0 14 16	...
107	Ditto	ditto	0 8 4	...
105	Ditto	Iron-stained kaolinic sinter	0 6 12	...
109	B to C	Kaolinic sinter	0 1 15	...
110	Ditto	ditto	1 9 9	...
112	Ditto	Siliceous sinter-sand	5 1 16	...
108	Ditto	ditto	0 8 4	...
113	Ditto	Yellow kaolinic sinter	1 19 4	...
114	Ditto	White kaolinic sinter	0 6 12	...
111	Ditto	Ironstone	0 11 10	0 17 23
115	C to D	ditto	2 9 0	...
138	Ditto	ditto	4 18 0	...
116	Ditto	White kaolinic sinter	0 8 4	...
117	Ditto	ditto	0 3 6	...
		Lady Musgrave Tunnel.		
1	25-30 feet from south end ...	White siliceous sinter	0 6 12	...
		No. 5 Tunnel.		
2	22 feet from south end	Yellow siliceous sinter	0 6 12	...
3	30 Ditto	ditto	0 11 10	0 1 15
4	89 Ditto	White sinter	0 1 15	...
5	132 Ditto	Ferruginous sinter	0 8 4	0 1 15
6	132 Ditto	White kaolinic sinter	0 6 12	...
7	207 Ditto	Loose running iron-sand	0 1 15	...
8	207 Ditto	ditto	0 6 12	...
9	240 Ditto	Ironstone	0 4 21	...
10	240 Ditto	Sinter	0 3 6	...
11	264 Ditto	Ironstone	0 4 4	...
12	264 Ditto	Kaolinic sinter	0 1 15	...
13	286 Ditto	ditto	0 1 15	...
14	353 Ditto	ditto	0 1 15	...
15	387 Ditto	ditto	0 14 17	0 4 21
16	430 Ditto	ditto	0 3 6	...
		No. 5 Crosscut.		
17	93-106 feet from east end ...	Ironstone	0 3 6	...
18	145 Ditto	Kaolinic sinter (?)	0 1 15	...
19	165 Ditto	Siliceous sinter	0 6 12	2 5 17
20	178 Ditto	Kaolinic sinter	0 4 21	...
21	192 Ditto	ditto	2 2 11	0 3 6
22	210 Ditto	ditto	2 5 17	0 4 21
23	238 Ditto	Siliceous sinter	0 3 6	...
24	292 Ditto	ditto	0 14 17	0 1 15
		No. 5a Tunnel.		
25	14 feet from south end	Siliceous sinter-sand	1 9 9	0 4 21
26	25 Ditto	Kaolinic sinter	0 11 10	Trace.
27	25 Ditto	Siliceous sinter	0 3 6	...
29	66 Ditto	ditto	0 4 21	...
30	104 Ditto	ditto	0 3 6	...
32	144 Ditto	ditto	0 6 12	...
33	180 Ditto	ditto	0 3 6	...
34	221 Ditto	ditto	0 3 6	...
35	242 Ditto	ditto	0 1 15	...
36	25 feet north of Crown Shaft ...	ditto	0 4 21	...
37	52 Ditto	ditto	0 3 6	...
38	96 Ditto	ditto	0 6 12	...
39	125 Ditto	ditto	0 3 6	...
40	182 Ditto	ditto	0 1 15	...
41	214 Ditto	ditto	0 1 15	...

ASSAYS—

ASSAYS—*continued.*

Assay No.	Locality.	Character of Rock.	Gold per Ton.	Silver per Ton.
			Ozs. dwts. grs.	Ozs. dwts. grs.
	Hopper Tunnel.			
43	182 feet from east end	Kaolinic sinter	1 4 12	0 1 15
44	182 Ditto	ditto	1 15 22	0 6 12
45	182 Ditto	ditto	0 6 12	...
46	182 Ditto	Siliceous sinter	0 4 21	0 3 6
47	20 feet up stopes	Kaolinic sinter	0 3 6	...
48	20 Ditto	ditto	0 3 6	...
49	20 Ditto	ditto	0 6 12	...
50	20 Ditto	ditto	14 14 4	0 3 6
51	20 Ditto	ditto	0 6 12	0 1 15
	Hopper Crosscut.			
52	113 feet north of tunnel	ditto	0 4 21	0 6 12
53	132 Ditto	ditto	0 3 6	0 8 4
54	177 Ditto	ditto	0 3 6	...
55	198 Ditto	ditto	1 1 6	21 1 9
56	226 Ditto	ditto	3 0 6	0 6 12
57	264 Ditto	ditto	0 3 6	...
58	312 Ditto	ditto	0 1 15	...
	Freehold (Eastern) Crosscut.			
59	101 feet from south end	Kaolinic sinter	0 4 21	...
60	112 Ditto	ditto	0 3 6	...
61	132 Ditto	ditto	0 1 15	...
62	166 Ditto	ditto	0 14 17	0 3 6
63	198 Ditto	ditto	7 2 2	0 3 6
64	220 Ditto	ditto	2 12 6	0 4 21
65	249 Ditto	ditto	2 10 15	0 3 6
66	264 Ditto	ditto	0 8 4	0 6 12
67	284 Ditto	ditto	0 13 1	0 4 21
68	323 Ditto	Siliceous sinter	0 19 14	0 3 21
69	378 Ditto	ditto	0 3 6	...
70	46 feet north of tunnel	Kaolinic sinter	0 14 17	Trace.
	Freehold Stopes.			
80	East face, 14 feet up	Ironstone	0 6 12	0 9 19
81	East face, 14 feet up, 17 feet north of 80	ditto	1 7 18	0 3 6
82	East face, 14 feet up, 17 feet north of 80	ditto	0 4 21	...
	Freehold Eastern Drive.			
71	40 feet east of crosscut	Ironstone	0 1 15	...
	Freehold Western Drive.			
72	7 feet west of crosscut	Siliceous sinter	0 8 4	0 3 6
73	26 Ditto	ditto	0 13 1	Trace.
74	66 Ditto	ditto	Trace.	...
75	94 Ditto	Ferruginous sinter	0 1 15	...
76	112 Ditto	ditto	Trace.	...
77	127 Ditto	Red kaolinic sinter	Trace.	...
78	148 Ditto	Red and white kaolinic sinter	0 3 6	...
79	148 Ditto	Ferruginous sinter	0 6 12	0 3 6
	Crosscut West of No. 1 Tunnel.			
85	147 feet west of tunnel	Pyrites	0 4 21	...
84	171 Ditto	ditto	0 6 12	...
83	228 Ditto	ditto	0 3 6	...
	Grasstree Tunnel.			
86	277 feet from mouth	Pyritous serpentine (?)	0 8 4	0 1 15
87	306 Ditto	Pyrites	0 3 6	...
88	429 Ditto	Sinter	Trace.	...
89	560 Ditto	Siliceous sinter	0 3 6	...
90	736 Ditto	Pyrites	Trace.	...
	Grasstree Crosscut.			
91	63 feet north of tunnel	Kaolinic sinter	0 4 21	...
92	82 Ditto	Pyrites with silica	0 1 15	...
93	82 Ditto	ditto	Trace.	...
94	73 feet south of tunnel	Pyritous rock	Nil.	...
	Grasstree Drive.			
95	11 feet from crosscut	Kaolinic sinter	0 4 21	...
96	31 Ditto	Siliceous sinter	0 17 23	3 6 23
97	66 Ditto	...	1 12 16	1 14 7
98	89 Ditto	Sinter	0 4 21	...

I am

I am permitted by the Directors to make use of a series of Assays of specimens collected by Mr. E. J. Dunn, of Melbourne, formerly Government Geologist of the Cape Colony. These assays fairly corroborate those given above. Mr. Dunn's method differed from mine in so far as he divided each tunnel into measured sections, from each of which he selected a sample for assay; whereas I did not take specimens of country-rock or dykes in which my own ideas as to the non-auriferous nature of the material were borne out by the experience of Mr. Lisle or his assistants. For convenience sake, Mr. Dunn's assays are thrown into tabular form :—

MR. DUNN'S ASSAYS.

No. 5 Tunnel.

No.	Distance in feet from south-west mouth of tunnel—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
1	20 to 27 *	0 8 4	0 1 15
2	27 „ 32	0 8 4	0 1 15
3	32 „ 38	0 9 19	0 3 6
4	38 „ 45	0 8 4	0 4 21
5	45 „ 51	0 6 12	0 3 6
6	51 „ 56	0 6 12	...
7	56 „ 62	Trace.	...
9	62 „ 68	Trace.	...
10	68 „ 74	0 8 4	0 1 15
11	74 „ 80	0 8 4	0 1 15
12	80 „ 86	0 11 10	0 1 15
13	86 „ 92	0 9 19	0 1 15
14	92 „ 98	0 4 21	0 8 4
15	98 „ 104	0 8 4	0 4 21
16	104 „ 110	0 8 4	0 4 21
17	110 „ 116	1 4 12	0 3 6
18	116 „ 122	1 12 16	0 4 21
19	122 „ 128	Trace.	...
20	128 „ 134	Trace.	...
21	134 „ 140	0 11 10	1 15 0
22	140 „ 146	4 9 20	0 17 23
23	146 „ 153 (Crosscut)	3 10 6	0 9 19
24	158 „ 161	0 [illegible] 1	0 13 1
25	161 „ 165	2 [illegible]	0 8 4
26	165 „ 171	0 4 [illegible]	0 19 14
27	171 „ 176	0 3 6	0 11 10
28	176 „ 182	0 3 6	0 8 4
29	182 „ 187	0 3 6	0 4 21
30	187 „ 193	0 3 6	0 8 4
31	193 „ 199	0 1 15	0 8 4
32	199 „ 205	0 3 6	0 6 12
33	205 „ 211	0 4 21	0 3 6
34	211 „ 217	0 6 12	...
35	217 „ 223	0 4 21	...
36	233 „ 239	0 9 19	0 3 6
37	239 „ 243	0 8 4	0 1 15
38	253 „ 259	0 4 21	...
39	259 „ 265	0 3 6	...

No. 5 Crosscut.

No.	Distance in feet from No. 5 Tunnel—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
46	14 to 20	0 14 17	0 1 15
45	59 „ 65	0 3 6	0 4 21
44	65 „ 71	1 17 14	2 4 2
43	71 „ 77	3 16 8	0 16 8
42	77 „ 83	3 10 6	3 6 0
41	83 „ 88	0 4 21	0 11 10
40	92 „ 95	0 9 19	0 4 21

No. 5A Tunnel.

No.	Distance in feet from southern mouth—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
1	6 to 12	0 6 12	...
2	12 „ 20	0 4 21	...
3	20 „ 23	0 19 14	0 3 6
4	45 „ 52	0 4 21	...
5	52 to 60	0 6 12	...
6	60 „ 66	Trace.	...
7	66 „ 72	0 3 6	...
8	72 „ 78	0 6 12	...
9	78 „ 84	0 9 19	0 3 6
10	84 „ 90	0 6 12	...
11	90 „ 96	0 3 6	...
12	96 „ 102	0 3 6	...
13	102 „ 108	0 4 21	...
14	108 „ 114	0 6 12	...
15	114 „ 120	0 4 21	...
16	120 „ 126	0 4 21	...
17	126 „ 132	0 3 6	...
18	132 „ 138	Trace.	...
19	138 „ 144	0 3 6	...
20	144 „ 150	Trace.	...
21	150 „ 156	0 4 21	...
22	156 „ 162	Trace.	...
23	162 „ 168	0 1 15	...
24	168 „ 174	0 1 15	...
25	174 „ 179 (Crown Shaft)	0 4 21	...
26	185 „ 190	0 3 6	...
27	190 „ 197	0 3 6	...
28	197 „ 204	0 3 6	...
29	204 „ 211	0 3 6	...

No. 5A Tunnel—*continued.*

No.	Distance in feet from southern mouth—*continued*—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
30	211 to 219	0 6 12	...
31	227 „ 232	0 3 6	...
32	232 „ 240	0 4 21	...
33	240 „ 245	0 4 21	...
34	251 „ 257	0 1 15	...
35	263 „ 268	Trace.	...
36	274 „ 280	Trace.	...
37	287 „ 293	0 3 6	...
38	299 „ 305	0 4 21	...
39	311 „ 316	0 1 15	...
40	322 „ 328	0 6 12	...
41	334 „ 340	0 3 6	...

Hopper Crosscut.

No.	Distance in feet from northern mouth—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
1	61 to 67	Trace.	
2	67 „ 73	Trace.	
3	73 „ 79	Trace.	
4	79 „ 90	Trace.	
6	90 „ 96	0 16 8	0 4 21
7	96 „ 102	1 6 3	0 3 6
8	102 „ 108	1 12 16	0 1 15
9	108 „ 113	3 2 1	0 3 6
10	113 „ 120	2 9 0	0 17 23
11	120 „ 126	2 15 12	1 2 20
*13	126 „ 132	2 12 6	1 1 6
14	132 „ 137	1 15 22	0 9 19
15	137 „ 144	0 16 8	0 6 12
16	144 „ 150	0 8 4	0 8 4
17	150 „ 156	0 13 1	0 9 19
18	156 „ 161	0 4 21	0 3 6
19	161 „ 167	0 8 4	0 6 12
†21	167 „ 173	0 16 8	0 6 12
22	173 „ 179	0 4 21	...
23	179 „ 185	0 8 4	0 3 6
24	185 „ 191	0 4 21	...
‡26	191 „ 197	0 6 12	0 4 21
27	197 „ 203	0 6 12	0 4 21
28	203 „ 209	0 4 21	...
29	209 „ 215	0 8 4	0 3 6
30	215 „ 222	Trace.	
§32	222 „ 232	1 7 18	0 3 6
§33	232 „ 240	2 0 20	0 4 21
§34	240 „ 249	1 12 16	0 3 6
§35	249 „ 258	2 4 2	0 3 6
§36	258 „ 268 (Hopper Tunnel)	1 12 16	0 3 6
§37	268 „ 275	1 7 18	0 3 6
§38	275 „ 278	2 12 6	0 4 21

* No. 12 gives 3 ozs. 3 dwts. 16 grs. gold and 1 oz. 2 dwts. 20 grs. silver per ton, but the position is not given on the plan.
† No. 20 gives 4 dwts. 21 grs. of gold per ton. Position not given.
‡ No. 25 gives 8 dwts. 4 grs. gold and 1 dwt. 15 grs. silver per ton. Position not given.
§ Stopes.

Freehold Crosscut.

No.	Distance in feet from southern mouth—	Gold per Ton. Oz. dwt. gr.	Silver per Ton. Oz. dwt. gr.
1	84 to 89	1 1 4	0 6 12
2	89 „ 99	0 4 21	...
3	120 „ 127	7 16 19	0 8 4
4	127 „ 132	6 5 18	0 6 12
5	132 „ 139	5 2 22	0 6 12
6	139 „ 145	4 4 22	0 9 19
7	145 „ 151	3 15 3	0 3 6
8	151 „ 157	2 7 8	0 3 6
9	157 „ 163	5 2 22	Trace.
10	163 „ 169	0 19 14	Trace.
11	169 „ 173 (Drive)	0 14 17	0 1 15
24	177 „ 182	0 3 6	...
*26	182 „ 188	1 9 9	0 3 6
27	188 „ 193	1 2 20	0 9 19
28	193 „ 199	0 4 21	...
29	199 „ 205	0 3 6	...
30	205 „ 211	0 3 6	...
31	211 „ 217	0 3 6	0 1 15
32	217 „ 223	0 16 8	0 1 15
33	223 „ 229	0 19 14	0 1 15
34	229 „ 235	0 14 17	Trace.
35	235 „ 240	Trace.	...
36	240 „ 246	1 1 6	0 1 15
37	246 „ 258 (Tunnel)	0 14 17	0 3 6

* No. 25 gives 1 oz. 6 dwts. 3 grs. gold and 4 dwts. 21 grs. silver per ton, but the position is not given on the plan.

Mr.

* The positions are taken from a tracing of a plan drawn to scale, and may not be absolutely correct.

MR. DUNN'S ASSAYS—*continued.*

No.	—	Gold per Ton.	Silver per Ton.
		Oz. dwt. gr.	Oz. dwt. gr.
	FREEHOLD EASTERN DRIVE.		
	Distance in feet east of Freehold Crosscut—		
12	0 to 6	1 4 12	0 3 6
13	6 ,, 13	1 1 6	0 4 21
14	13 ,, 19	1 6 3	0 4 21
15	19 ,, 25	1 11 0	0 4 21
16	25 ,, 31	Trace.	...
	FREEHOLD WESTERN DRIVE.		
	Distance in feet west of Freehold Crosscut—		
17	0 to 6	1 6 3	Trace.
18	6 ,, 12	2 4 2	Trace.
19	12 ,, 18	1 4 12	0 1 15
20	18 ,, 24	0 14 17	Trace.
21	24 ,, 30	0 4 21	...
22	59 ,, 64	0 3 6	...
23	64 ,, 70	0 1 15	...
24	70 ,, 76	0 3 6	...
	STOPES BELOW FREEHOLD CROSSCUT AND DRIVE.		
	Distance in feet from Winze at south end—		
3	25 to 34	1 6 3	0 3 6
2	34 ,, 42	0 13 1	0 3 6
1	42 ,, 49	1 6 3	0 4 21
	CROSSCUT WEST OF NO. 1 TUNNEL (PYRITES).		
	Distance in feet west of Tunnel—		
1	49 to 52	Trace.	...
2	52 ,, 55	Trace.	...
3	58 ,, 61	0 16 8	...
4	61 ,, 64	Trace.	...
5	64 ,, 67	Trace.	...
6	67 ,, 70	Trace.	...

No.	—	Gold per Ton.	Silver per Ton.
		Oz. dwt. gr.	Oz. dwt. gr.
	CROSSCUT WEST OF NO. 1 TUNNEL (PYRITES)—*continued.*		
	Distance in feet west of Tunnel—*continued.*		
7	70 to 73	Trace.	...
8	73 ,, 76	Trace.	...
9	76 ,, 79	Trace.	...
10	92 ,, 95	Trace.	...
11	95 ,, 98	Trace.	...
12	98 ,, 101	Trace.	...
13	101 ,, 104	Trace.	...
14	104 ,, 107	0 4 21	...
15	107 ,, 110	0 3 6	...
16	110 ,, 113	Trace.	...
17	113 ,, 116	0 1 15	...
18	116 ,, 119	0 3 6	...
19	119 ,, 122	Trace.	...
20	122 ,, 125	0 1 15	...
21	125 ,, 128	0 1 15	...
22	128 ,, 131	0 1 15	...
23	131 ,, 134	0 1 15	...
24	134 ,, 137	Trace.	...
25	137 ,, 140	Trace.	...
26	140 ,, 143	Trace.	...
27	143 ,, 146	0 1 15	...
28	146 ,, 149	Trace.	...
29	149 ,, 152	Trace.	...
30	152 ,, 155	Trace.	...
32	158 ,, 161	Trace.	...
34	164 ,, 167	Trace.	...
36	170 ,, 173	Trace.	...
38	176 ,, 179	0 3 6	...
40	182 ,, 185	Trace.	...
42	188 ,, 191	0 3 6	...
44	194 ,, 197	0 4 21	...
46	200 ,, 203	Trace.	...
48	206 ,, 209	0 1 15	...
50	212 ,, 215	0 1 15	...
52	218 ,, 221	6 12	...

CONCLUSION.

In Plates I. to IV. the various underground workings are drawn to scale, so that the plan of comparing adjacent and approximately parallel sections at different levels, which was adopted in the Second Report, can be again followed out. The sections given in the Second Report are reproduced whenever their reproduction is essential. In the new sections I have not considered it necessary to distinguish, for geological purposes, between siliceous sinter which is pure and siliceous sinter which is more or less mixed with kaolin.

The western and highest portion of the Mount is intersected from north to south, at successive levels, by No. 2 Tunnel, No. 5A Tunnel, the Western Freehold Crosscut, and No. 1 Tunnel. The diagram, Section N (Plate I.), shows what light is thrown on the structure of the Mount along the line of the tunnel No. 5A by the other tunnels and crosscut above named; but the western face of the No. 4 Bench being practically on the same level as No. 2 Tunnel, and nearly coincident with the line of the underlying No. 5A Tunnel, supplies a portion of the data made use of in constructing the section.

Section O (Plate II.) shows the structure of the eastern portion of the Mount, and is constructed by piecing together the Lady Musgrave and Lion's Den Benches and the Hopper, Freehold (Eastern), and Grasstree Crosscuts, all of which cross the hill at no great distance apart, and approximately parallel.

In Sections P to W (Plates III. and IV.) the remaining underground workings are delineated. Although too far apart to be placed on the same section, the No. 5 Crosscut, Freehold Tunnel and Crosscut, Grasstree Tunnel and Drive, and Hopper Tunnel, all of which cross the hill from south-east to north-west, may be compared with advantage.

It is well known that the prevalence at the lower levels of what is called "kaolin ore" has of late brought the problem of economical treatment prominently before the shareholders, as ore of this class is not capable of treatment by chlorination. This ore, which I have named throughout "kaolinic sinter," is in reality a very fine siliceous sinter mixed, sometimes to the extent of one-third, with impalpably fine white felspathic mud. In the early surface workings the purity of Mount Morgan gold was one of the most notable features of the mine, but an appreciable quantity of silver is now frequently met with. On looking over the assays, the quantity of silver appears to be in proportion to the extent to which the ore is kaolinic; and Mr. G. H. Irvine, who is experimenting on the treatment of the kaolin ores, informs me that after the kaolin has been mechanically removed the gold in the siliceous residue of the ore is almost chemically pure.

The ironstone appears to be for the most part confined to the upper levels.

I took the opportunity, when at Mount Morgan, of visiting Mount Victoria, where gold is met with in the base beds of the Desert Sandstone. The workings will form the subject of another report.

ROBERT L. JACK.

Geological Survey Office,
Townsville, 15th April, 1892.

APPENDIX.

APPENDIX.

The issue of this Report having been delayed owing to the time occupied in preparing the plans and plates, I visited the mine on 20th June last for the purpose of seeing the latest workings.

The Lady Musgrave Bench has been extended southward and westward over the ground lying between the points E and F (*see* Plan No. 2), and the western side of the Lady Musgrave Tunnel, which latter is therefore a thing of the past. In No. 4 Bench the recent workings have been confined to the northern corner (S.-T.), which has been worked for some distance to the north on the good stone referred to in the Report. The Hopper Stopes have been carried up to the surface (where they have a sectional area of about 50 feet diameter) 46½ feet above the Hopper Tunnel, and 26 feet below the Lady Musgrave Bench. The Freehold Stopes have been considerably extended on the upper platforms and carried up to the level of the Freehold Crosscut. Lastly, a new tunnel has been commenced in the Linda Creek Valley, and is designed to cut the Crown Shaft below the level of the Sunbeam Tunnel.

The Freehold Stopes commence at No. 1 Platform, 41 feet below the level of the Freehold Crosscut. Platform No. 2 is 7 feet 9 inches above No. 1, and platforms 2, 3, 4, 5, and 6 are the same distance apart, No. 6 being 2 feet 3 inches below the crosscut. The large felstone dyke (*the* "Kaolin Dyke" of the First Report) is seen south of the shaft (the black square on plan No. 2), at the No. 2 Platform, where it is about 20 feet in thickness. About 10 feet below this level, payable kaolinic sinter is now being excavated from the south side of the dyke—a proof that the dyke does not "cut off" the auriferous deposit. Although the fact is not new, its recurrence at such a low level is very satisfactory. Recent tunnelling has shown that scores of similar dykes intersect the auriferous deposit, and as they must be of more recent date than the latter, they could not possibly (as they did not exist) have interfered with the deposition of the gold. I may say that I gather, from what the manager and sub-managers have often pointed out to me, that the ground in immediate contact with the dykes is frequently poor, while a few feet or yards away it may be richer than usual, and the idea has suggested itself that the dykes, in coming up in a molten condition through the auriferous deposit, may, either through heat or electrical energy, or both combined, have had some influence in volatilising the gold and depositing it at a little distance, where of course the gold thus deposited would be added to what was there before.

Some ironstone, very rich in gold, has lately been obtained from near the eastern side of the No. 3 Platform of the Freehold Stopes. A portion of this deposit, not so rich as what had been taken out, but still averaging, I was informed, from 6 ozs. to 9 ozs. per ton, was being excavated when I visited the mine, from a face about 15 feet in length. Its position may be located on Plan No. 2 by plotting as follows from the north-east corner of the shaft:—(*a*) E. 15° S., 18 feet; (*b*) N. 15° E., 10 feet; (*c*) E. 15° S., 6 feet; (*d*) N. 15° E., 15 feet; (*e*) E. 15° S., 6 feet; and (*f*) N. 15° E., 15 feet. The face in question was that named (*f*), and consisted of hæmatite ore in preponderating mass, with a mixture of siliceous and kaolinic sinter. The richest specimens were obtained about 15 feet west of this face, and 5 feet above the platform. Specimens shown to me were equal to anything the mine has yet produced, and I could easily believe that picked samples might yield gold at the rate of 1,000 ozs. to the ton.

The same rich ironstone was met with in the stope above No. 4 Platform, but not in No. 5 or No. 2. Above No. 4 Platform its position may be located as follows, commencing at the north-east corner of the shaft:—(*a*) S. 15° W., 10 feet; (*b*) E. 15° S., 18 feet; (*c*) N. 15° E., 10 feet; (*d*) W. 15° N., 6 feet; (*e*) N. 15° E., 35 feet; (*f*) W. 15° N., 6 feet; (*g*) N. 15° E., 20 feet. The richest specimens in this level of the stope extended for about 12 feet north of a point 6 feet west of the south end of (*g*), and are said to have been nearly as good as those from the lower level. Sections (*e*), (*f*), and (*g*) are composed of ironstone and kaolinic sinter, but with less of the former than in No. 3 level. The sinter on No. 4 level is unusually good, especially on the east side of the stopes. There was a patch of very rich sinter in the shaft between the fourth and fifth levels.

In the Hopper Stopes there is little to remark except the persistence of the class of "kaolin ore" referred to in the report (*see* "Hopper Tunnel" and "Hopper Crosscut") right up to the base of the ironstone above the Lady Musgrave Bench. Our present knowledge of the Freehold and Hopper Stopes seems to give additional point to the surmise (shadowed forth in the Report in the sixth paragraph under the heading "M. to N.") that important developments may be looked for on the southern slope of the Mount.

R. L. J.

Geological Survey Office, Elizabeth street,
Brisbane, 23rd June, 1892.

Price 2s. 6d.]

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No 1

PLAN OF THE WORKINGS

MOUNT MORGAN GOLD MINE QUEENSLAND

to accompany

"Third Report on the Mount Morgan Gold Deposits"

BY

ROBERT L. JACK,
Government Geologist.

1892

Scale 2 Chains to an Inch

Links 0 50 100 2 3 4 5 6 7 8 Chains

Feet 0 66 132 264 396 528

PRINTED, AT THE GOV' ENGRAVING, & LITHOGRAPHIC OFFICE BRISBANE - QUEENSLAND -

NATIONAL MUSEUM

GEOLOGICAL SURVEY

GT MT MORGAN EXTD CO OF LONDON

CRUSHING MACHINE

CONSOLIDATED CLAIM No 452

LEASEHOLD No 94

No 4 Crown Shaft

Bench

Lion's Den Bench

Lady Musgrave No 4 Bench

Lady Brassey Shft

SUNBEAM TUNNEL

Halls Gully

CALLAN'S KNOB Co

Platform Shaft

Engine House

LEASEHOLD No 95

Sugar Loaf Shaft

SUGAR LOAF TUNNEL

ROAD TUNNEL

CONSOLIDATED CLAIM No 452

Sugar Loaf Gully

Road

SOUTH MOUNT MORGAN Co

WESTERN BOUNDARY OF FREEHOLD

Grass Tree Gully

Mundic

FREEHOLD

No 1

PLAN OF THE WORKINGS

MOUNT MORGAN GOLD MINE QUEENSLAND

to accompany

"Third Report on the Mount Morgan Gold Deposits"

BY

ROBERT L. JACK,
Government Geologist.

1892

Scale 2 Chains to an Inch

Links 0 50 100 2 3 4 5 6 7 8 Chains

Feet 0 66 132 264 396 528

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NATIONAL

No 2

PLAN OF

MOUNT MORGAN

QUEENSLAND

Showing Localities from which Specimens referred to in the Report were taken, to accompany "Third Report on the Mount Morgan Gold Deposits"

BY

ROBERT L. JACK
Government Geologist

1892

Scale 66 feet to an Inch

N

Mag. N.

TUNNEL

CROSS CUT FROM No 2 TL

Crown Shaft

No 4 Bench

Level of No 4 Bench

CROSS CUT FROM No 1 TUNNEL

SUNBEAM Lady Brassey Sh.

No 2

No 1

FREEHOLD

GRASSTREE

No 5

Lion's Den Bench

Level of No 4 Bench

Lady Musgrave =No 4 Bench

CROSSCUT

DRIVE FROM No

E.H. CROSSCUT

GRASS TREE DRIVE

HOPPER CROSSCUT

LADY MUSGRAVE TUNNEL

Level of No 1 Bench

A B C D E F G H I J K L M N P Q R S T U V

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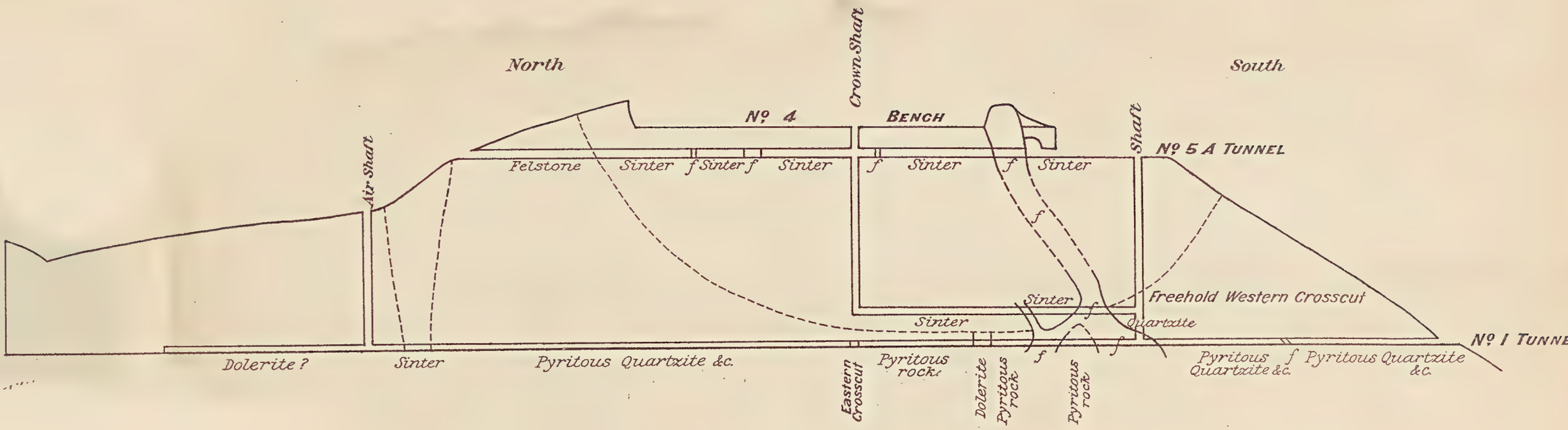


DIAGRAM SECTION N. IN THE LINE OF No 5 A TUNNEL

100 Feet to an Inch

(The dotted lines represent the approximate boundary of the auriferous deposit as far as the workings show)

NATIONAL MUSEUM
VICTORIA.

South South West

North North East

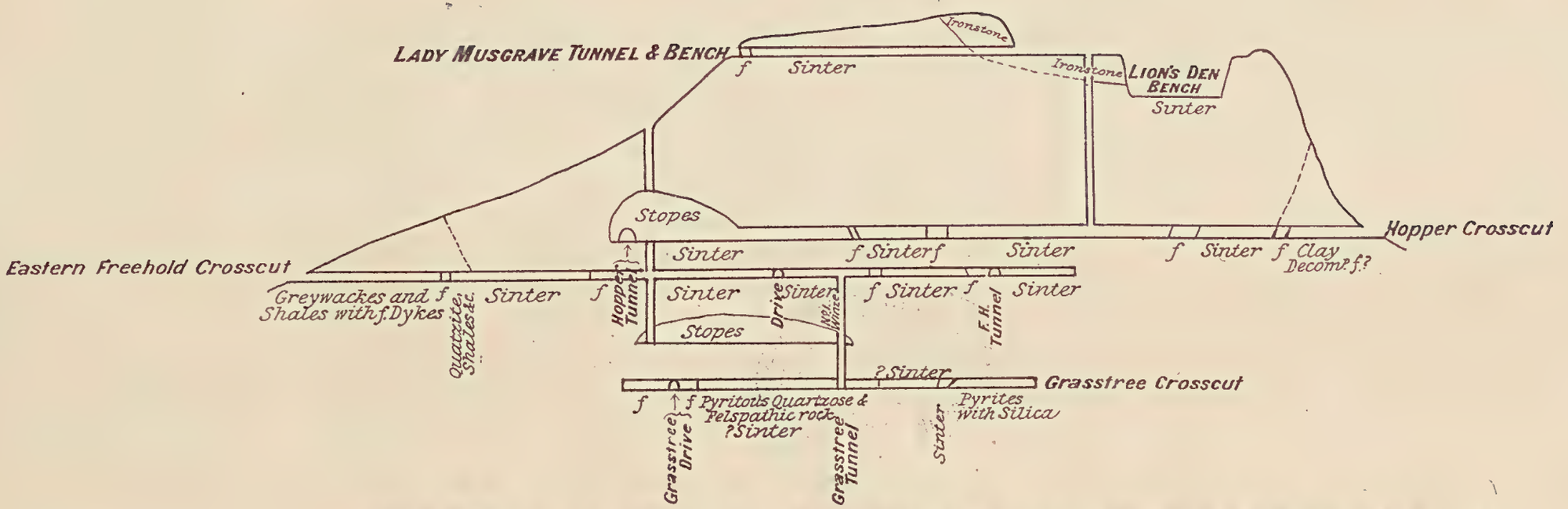
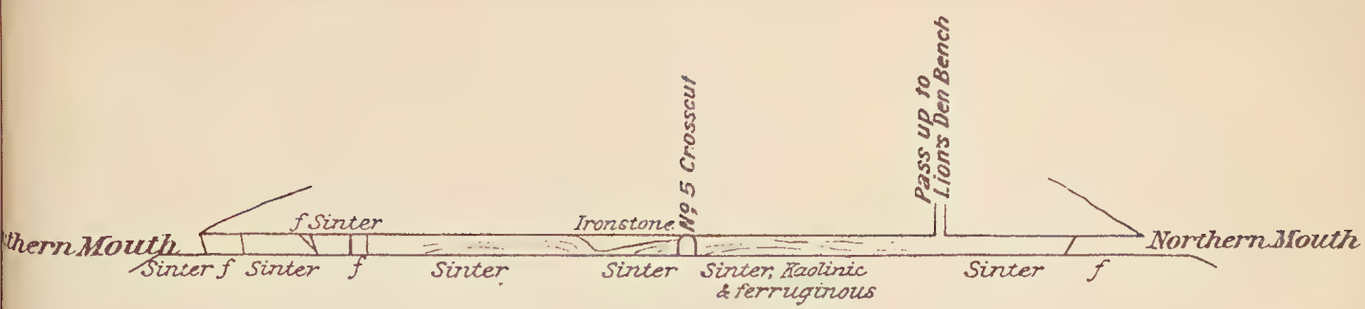


DIAGRAM - SECTION O. ALONG THE LINE OF THE HOPPER CROSSCUT

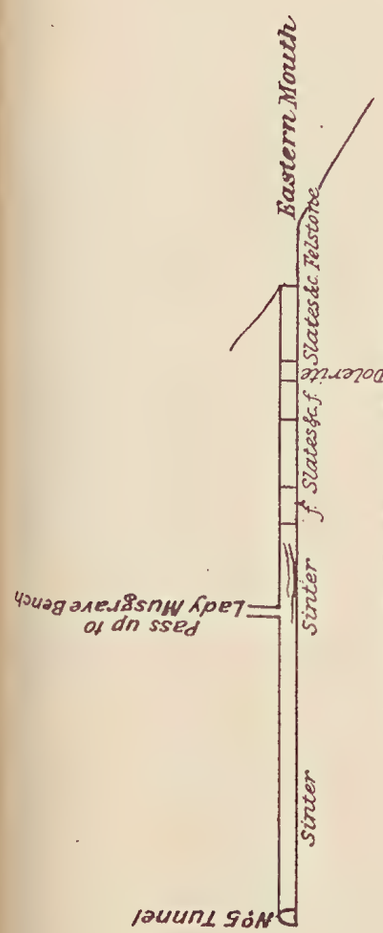
100 Feet to an Inch.

(The dotted lines represent the approximate boundaries of the auriferous deposit as far as the workings show.)


Pass up to Lion's Den Bench
No 5 Crosscut
f Sinter
Ironstone
thern Mouth
Northern Mouth
Sinter f Sinter f Sinter Sinter Sinter, Kaolinic & ferruginous Sinter f

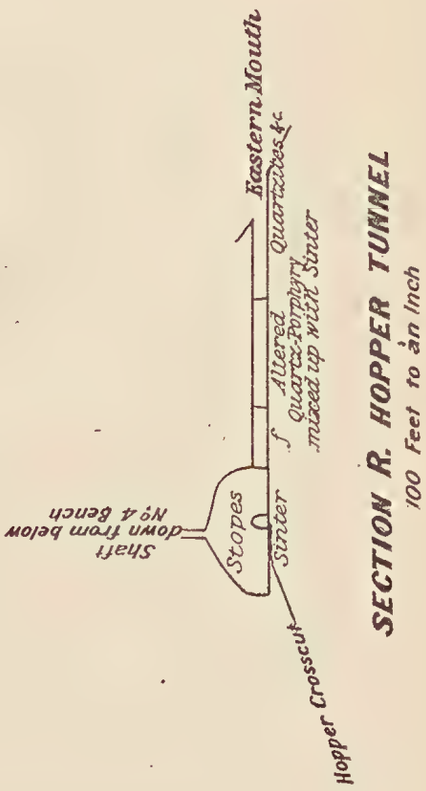
SECTION P. Nº 5 TUNNEL

100 Feet to an Inch



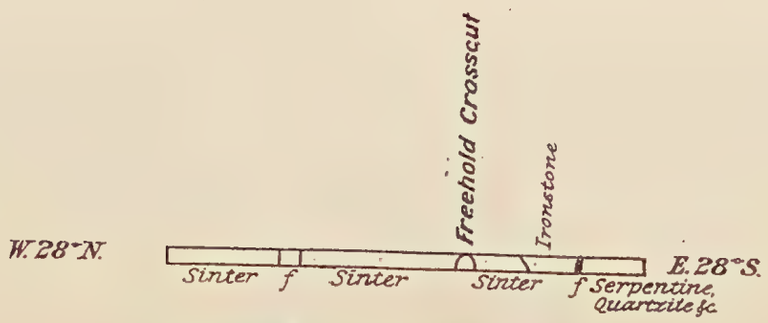
SECTION Q. Nº 5 CROSSCUT

100 Feet to an Inch



SECTION R. HOPPER TUNNEL

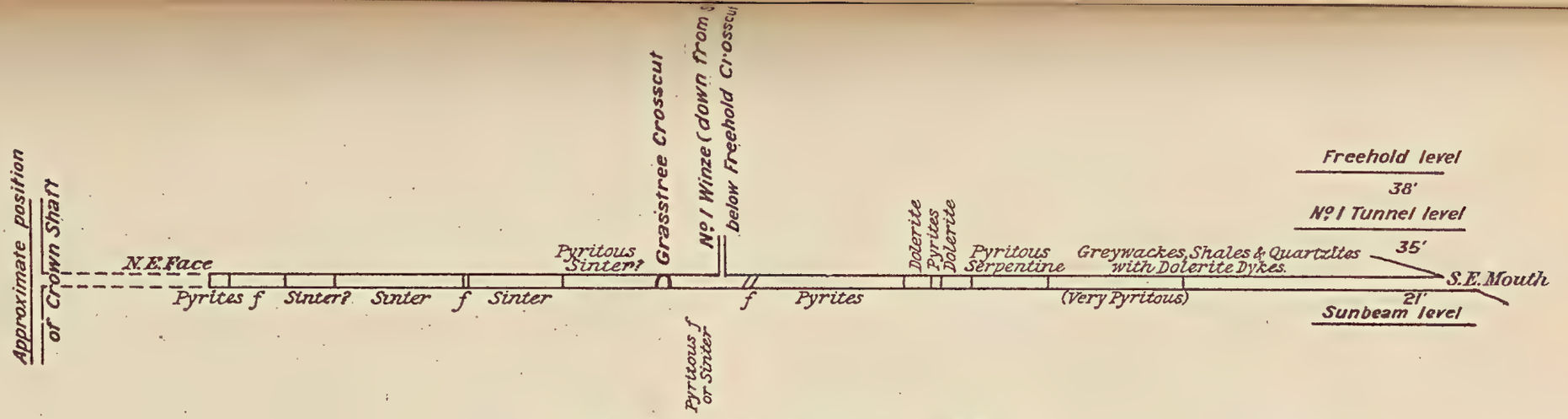
100 Feet to an Inch



SECTION S. FREEHOLD DRIVE

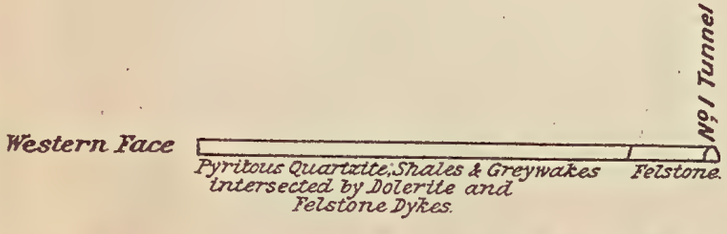
100 Feet to an Inch

Victoria



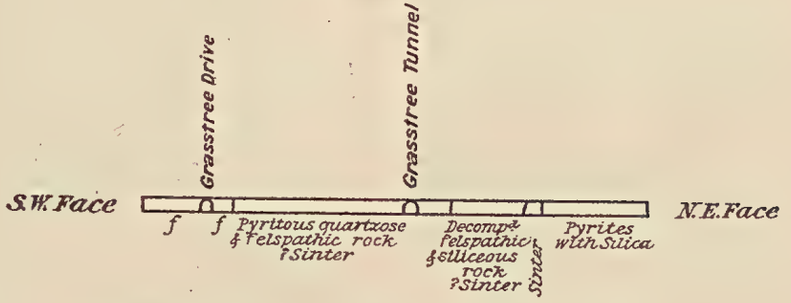
SECTION U. GRASSTREE TUNNEL

100 Feet to an Inch



SECTION T. CROSSCUT WEST OF No 1 TUNNEL

100 Feet to an Inch



SECTION V. GRASSTREE CROSSCUT.

100 Feet to an Inch

SECTION W. GRASSTREE DRIVE.

100 Feet to an Inch

PLATE V.

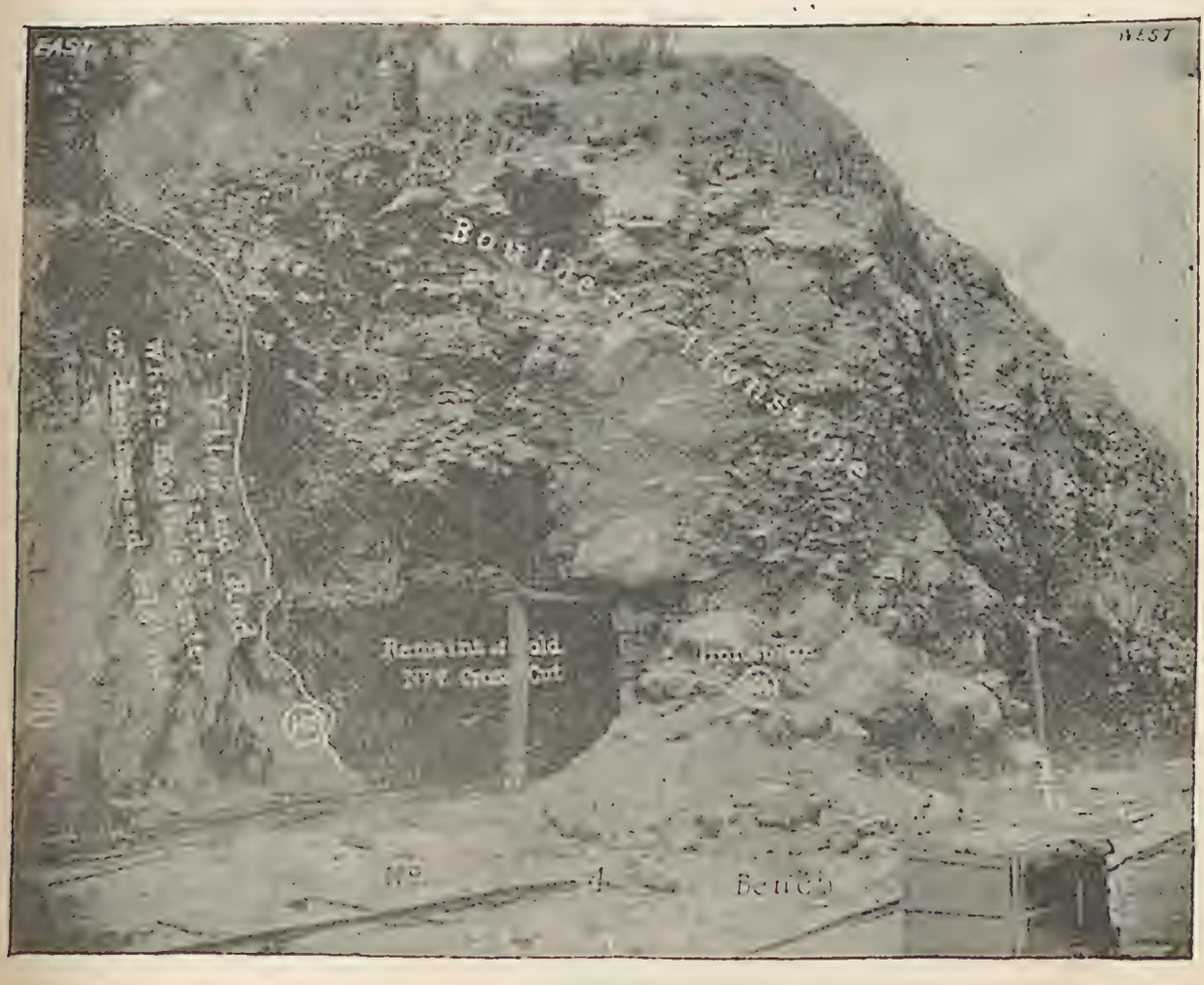
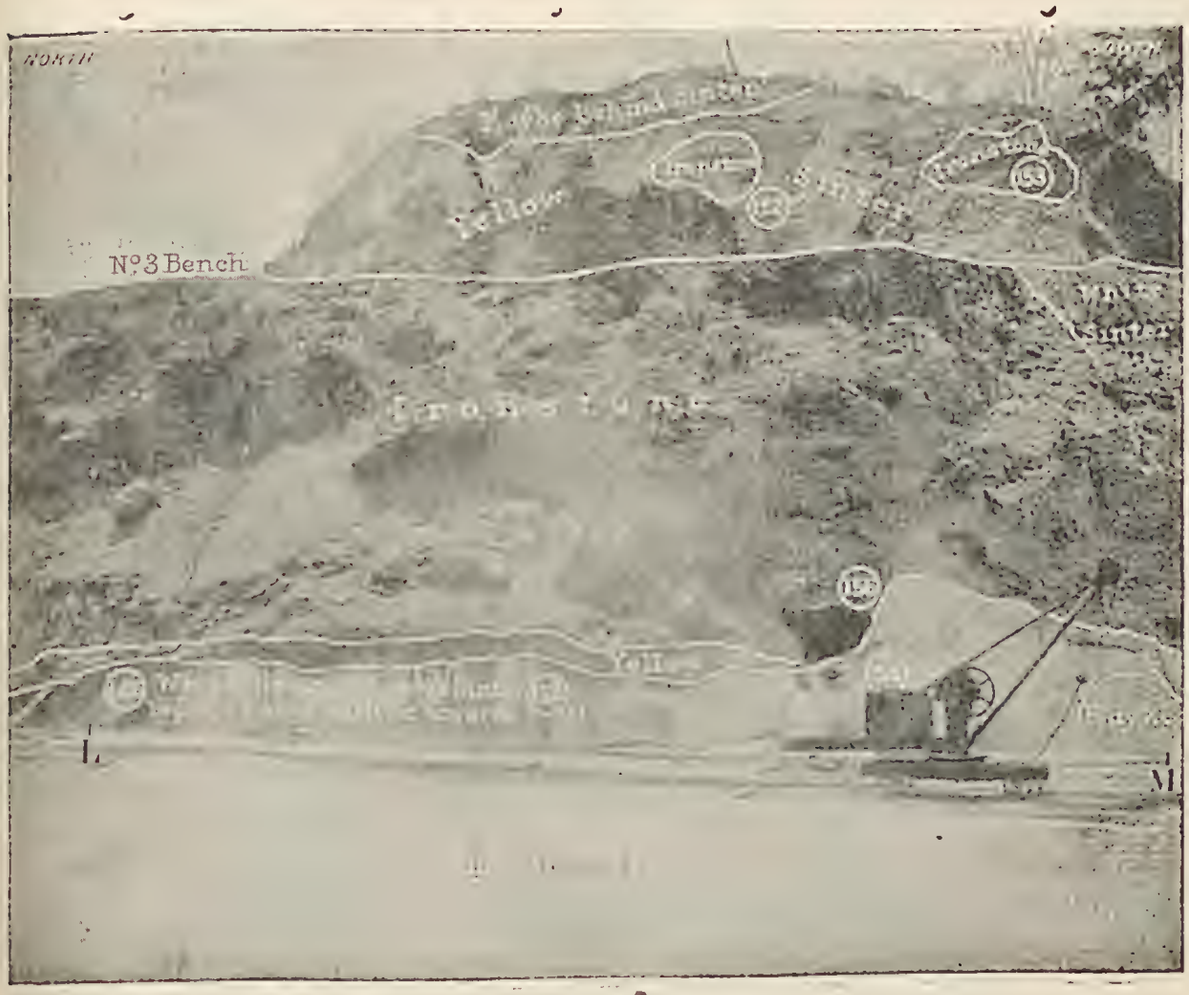


PLATE VI.

PLATE VII.



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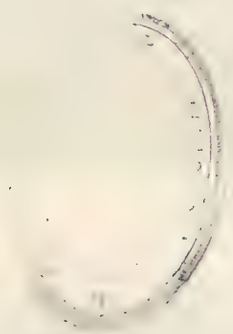

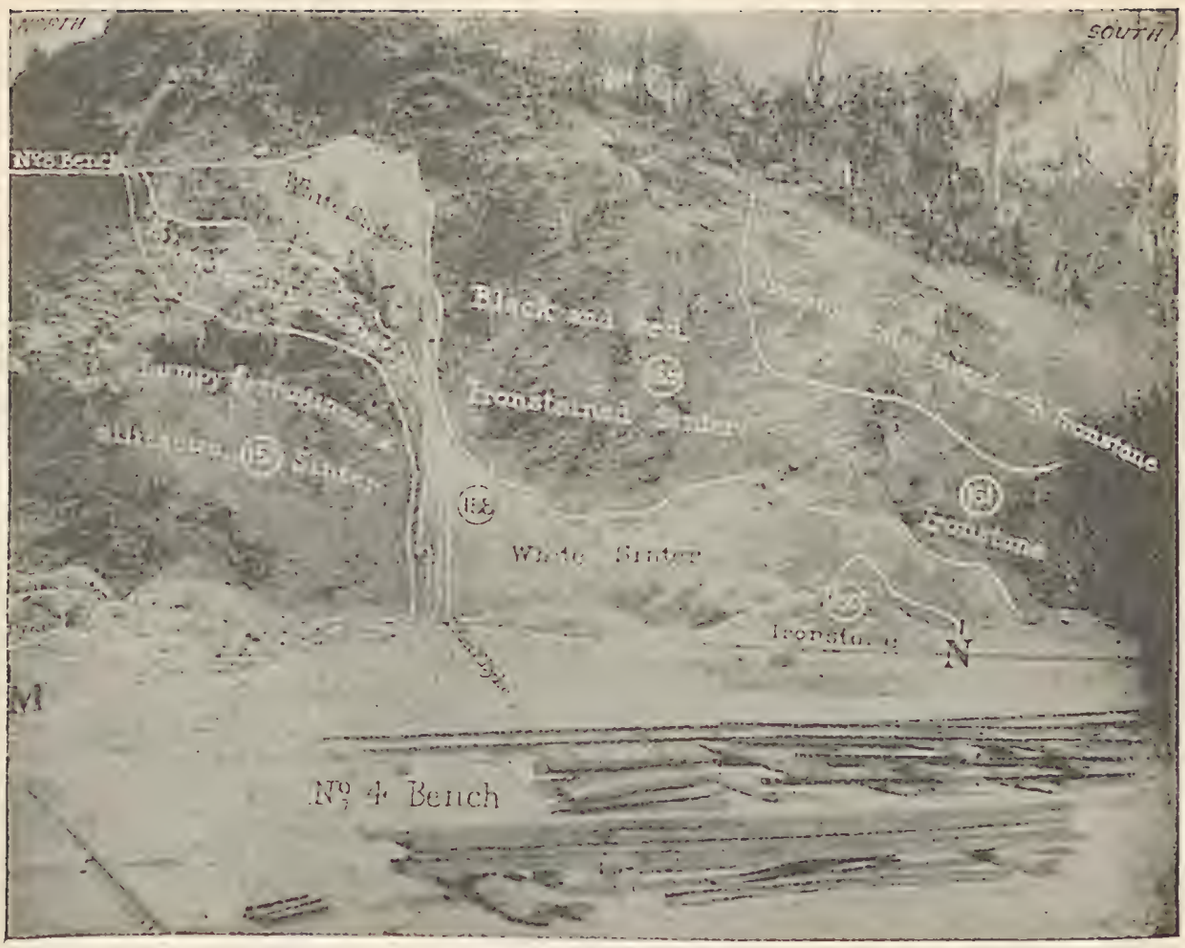

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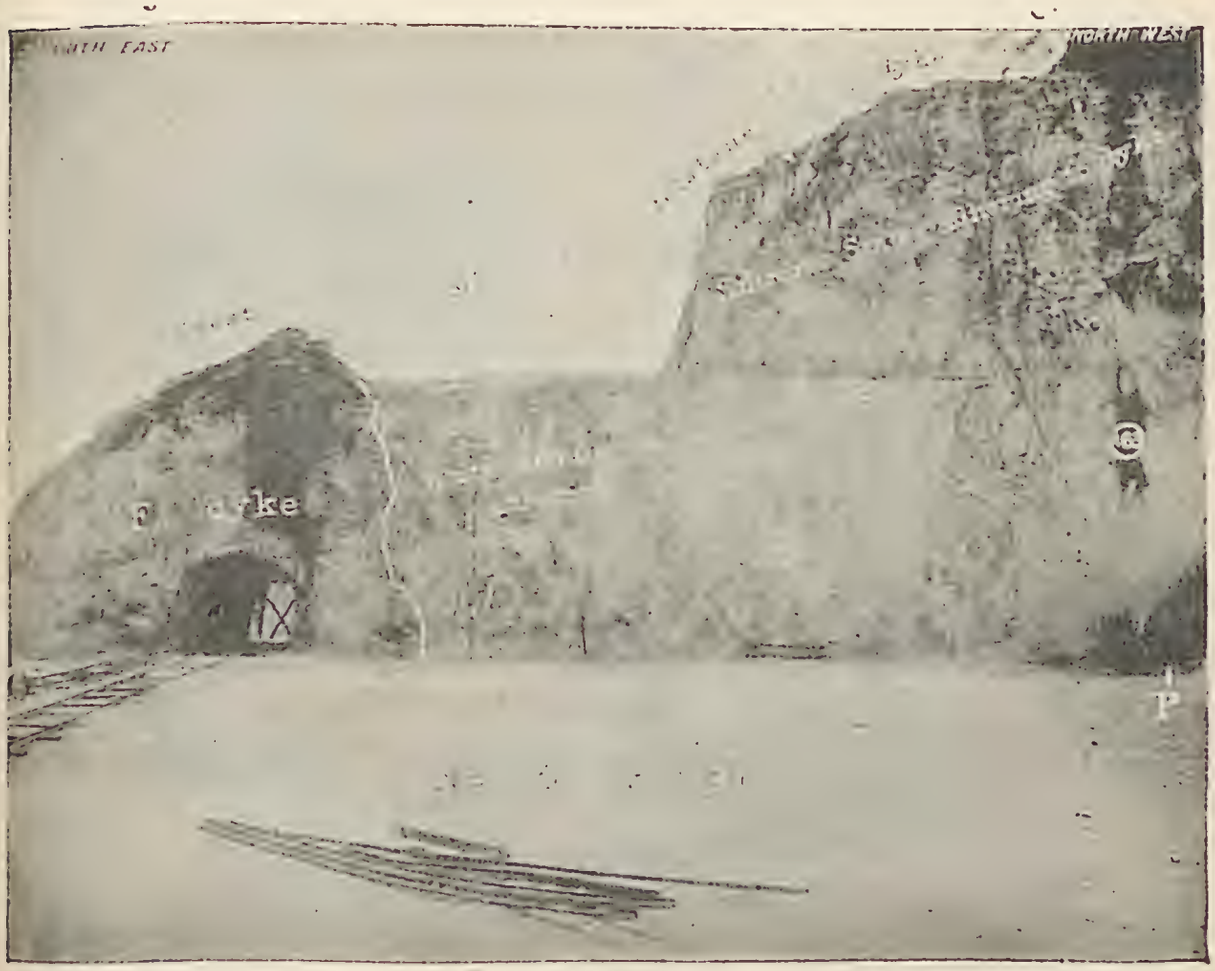


PLATE X.

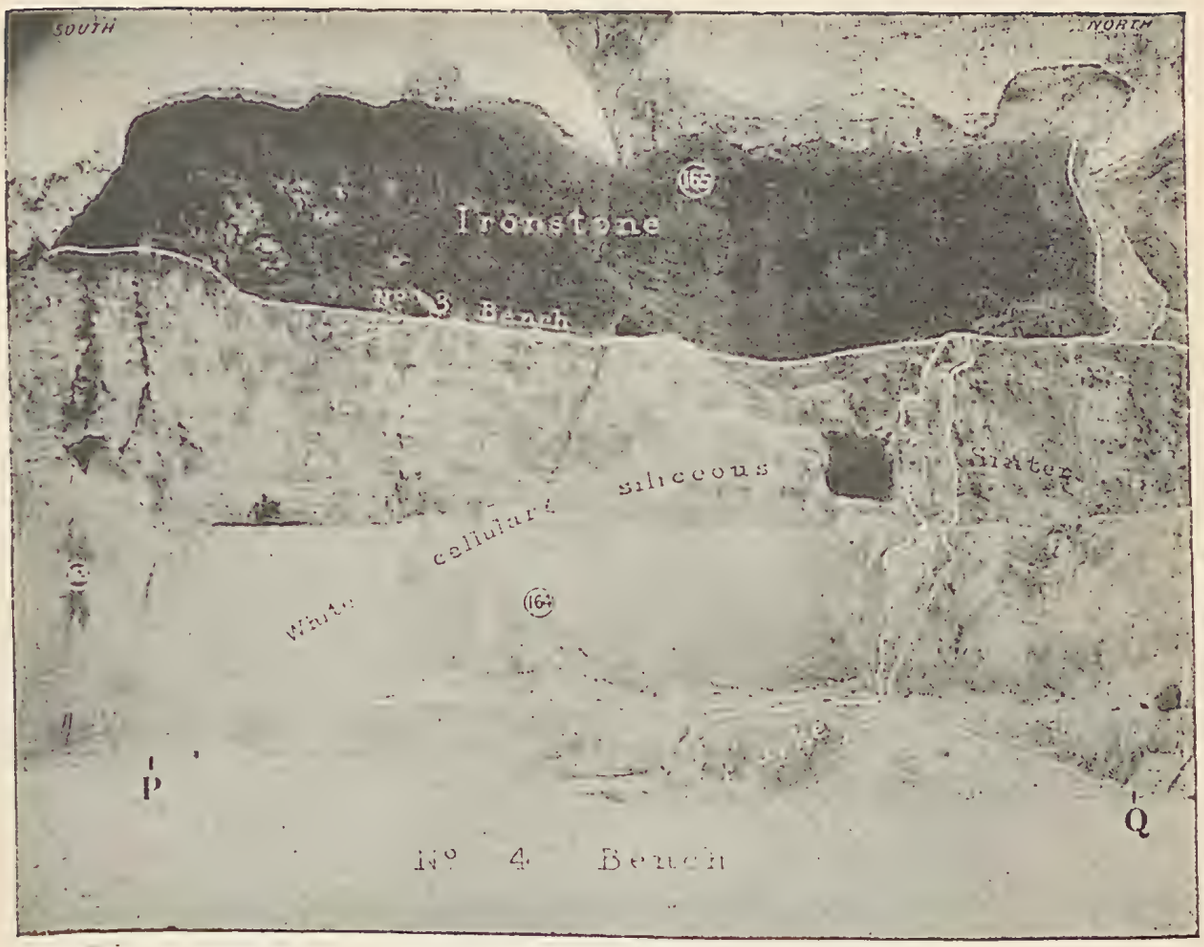


PLATE XI.

PLATE XII.

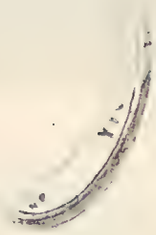


PLATE XIII.

PLATE XIV.

PLATE XV.

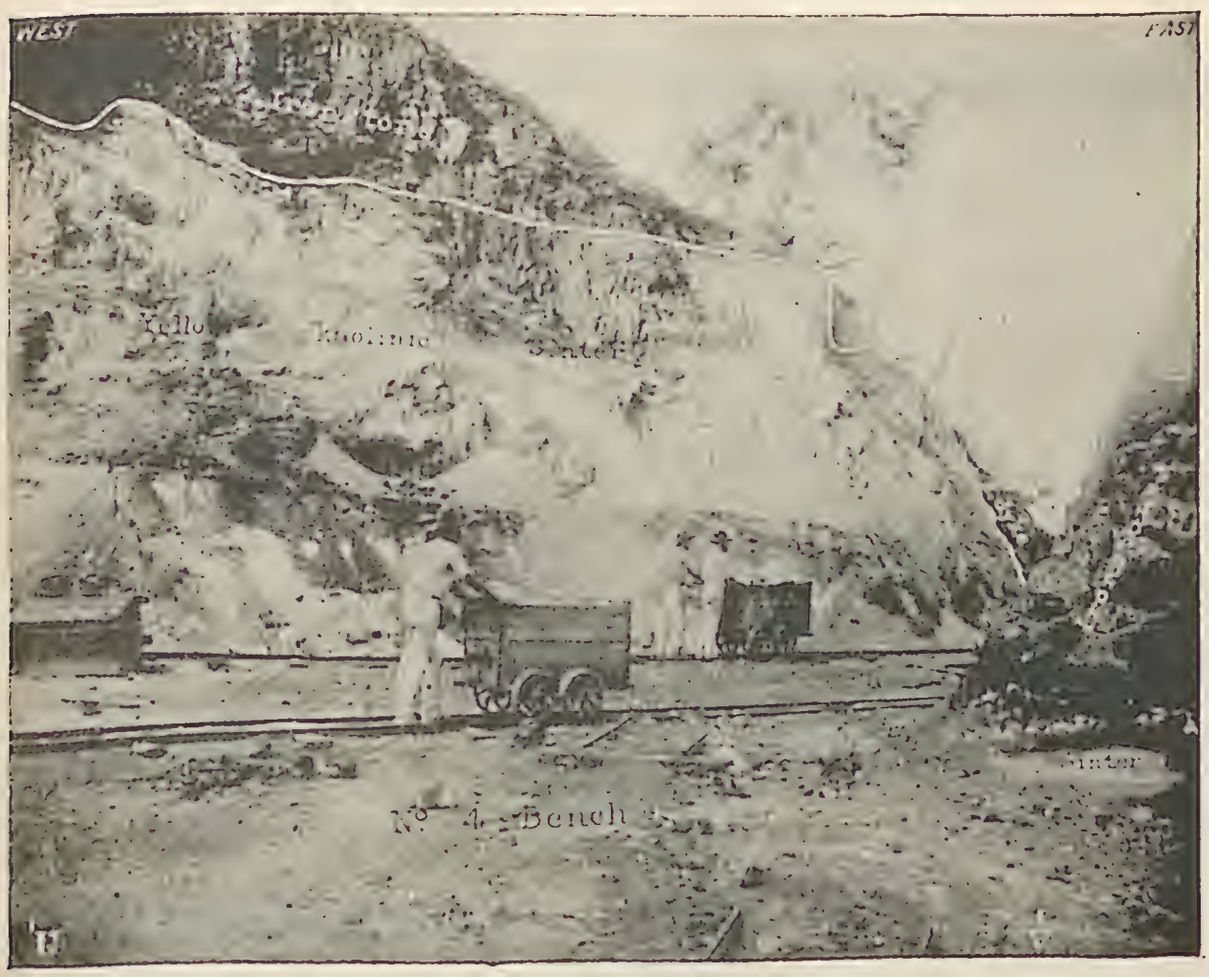


PLATE XVI.

VICTORIA

Plate XVII.

Plate XVIII.

PLATE XIX.

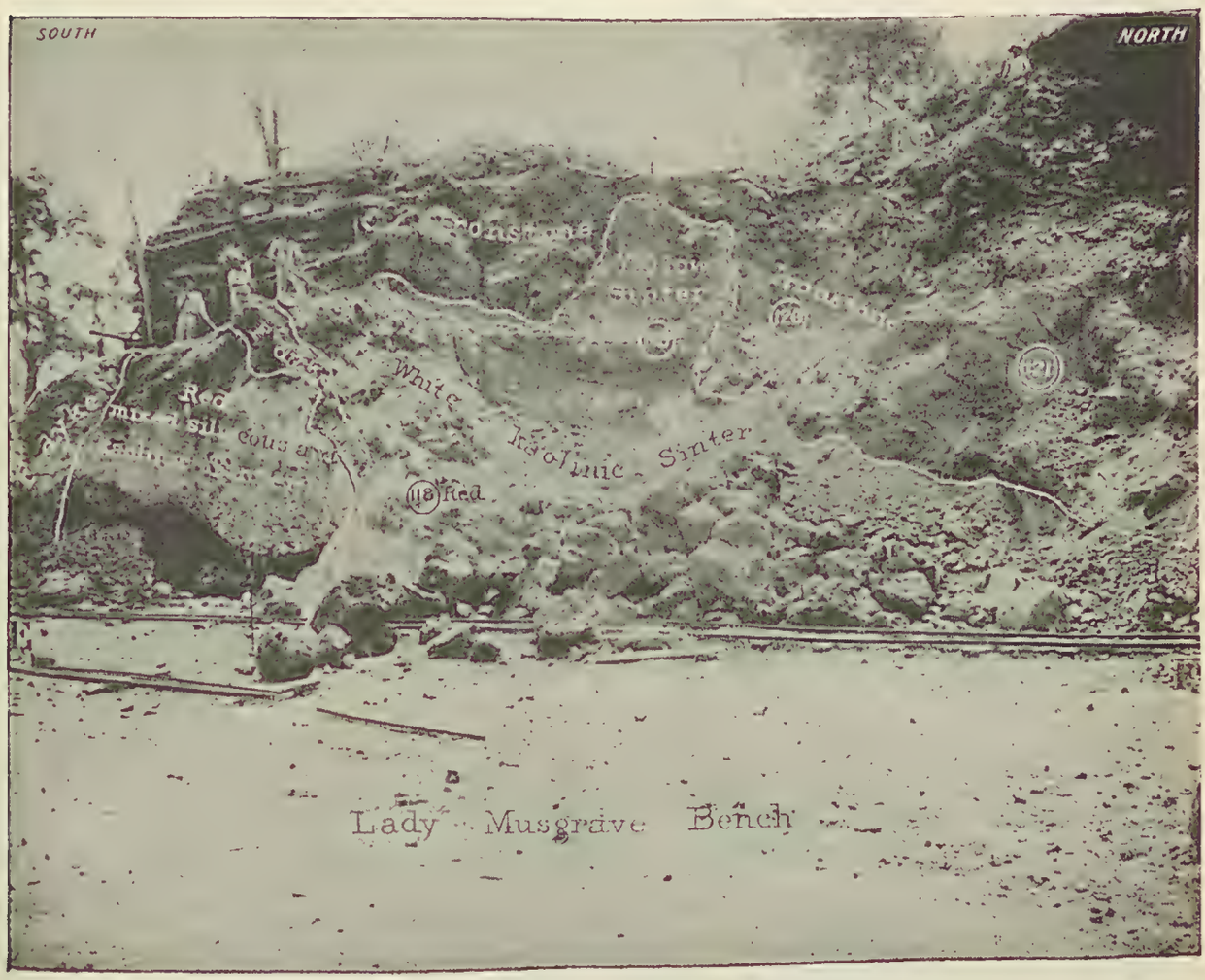


PLATE XX.

VICTORIA

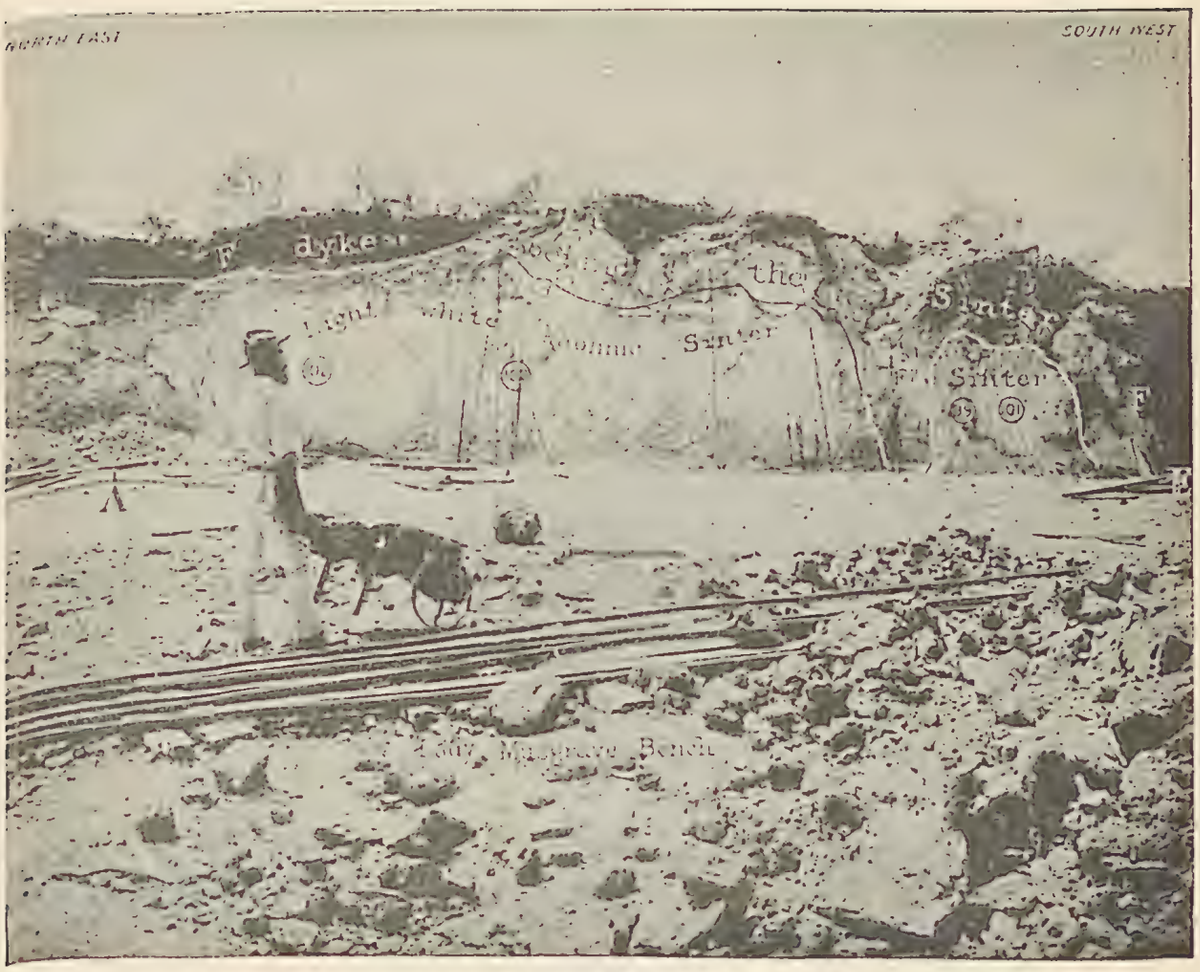


PLATE XXI.

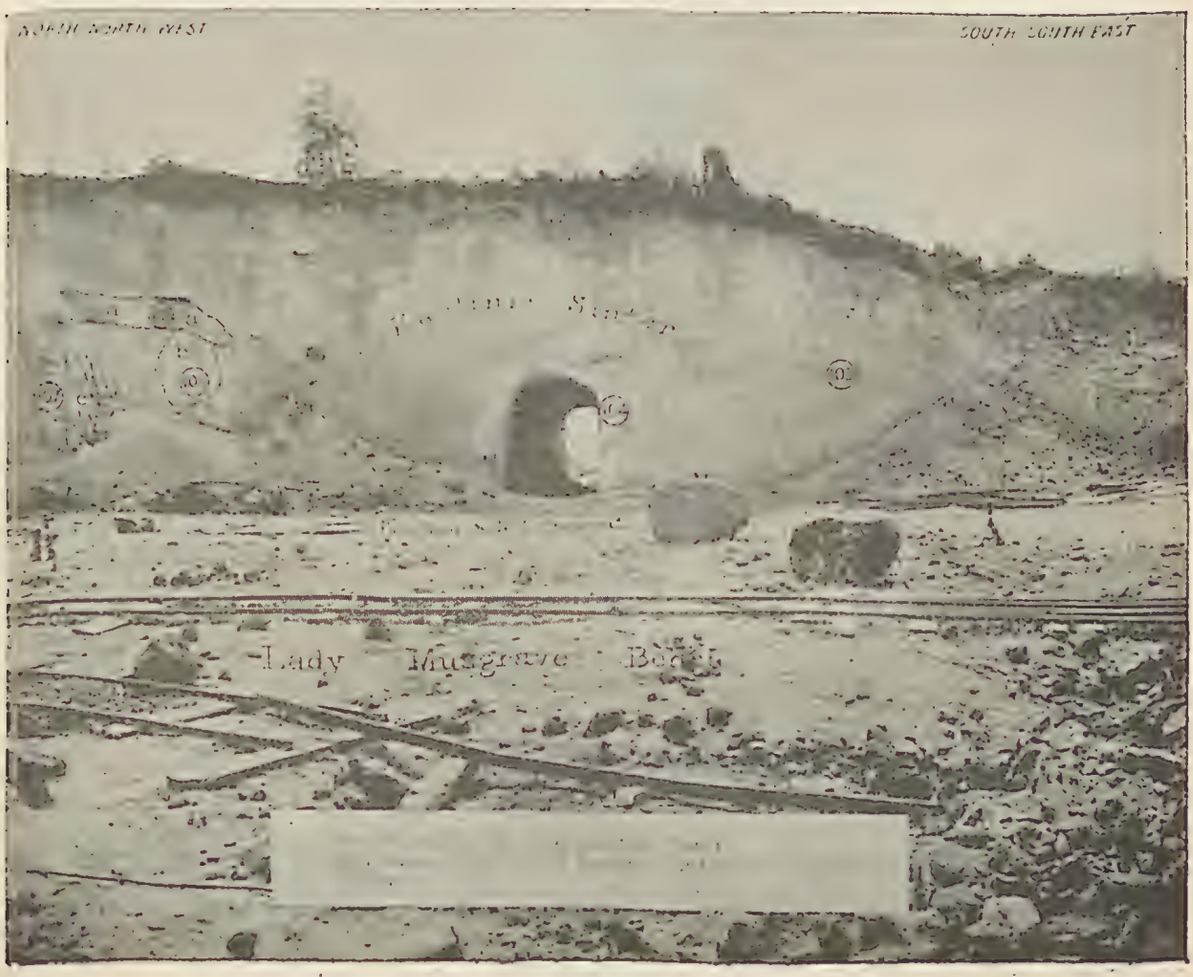


PLATE XXII.

VICTORIA

PLATE XXIII.

PLATE XXIV.

84

23 NOV 1935 VICTORIA

1892.

QUEENSLAND.

STYX RIVER COAL FIELD.

(REPORT ON, BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST.)

WITH MAP AND PLATE.

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Geological Survey,
Brisbane, 28th March, 1892.

Sir,—I have the honour to hand you herewith Mr. Rands' Report on the Styx River Coal Field, together with a Geological Map.

I have, &c.,
ROBERT L. JACK.

The district under notice lies to the north-west of Rockhampton, between Broad Sound or Connor's Range and the coast. It includes the country between a point about twelve miles west-north-west of Marlborough and Saint Lawrence Township.

The presence of coal, and Coal Measures, in this district has been known of for some time, but up to the present no Geological Report on the district has been issued.

The country occupied by the coal beds is generally flat, or gently undulating, and is only at a slight elevation above the sea-level. It is traversed by several creeks, all of which empty themselves into Broad Sound.

On Wilangi and Waverley Runs there are extensive sandy marine plains, which once formed a portion of the Bay. They are evidence of the gradual elevation of the land here in recent times. Some of the creeks, for instance Amity Creek, Wilangi, terminate at the margin of these flats.

Shortly after passing Yaamba on the road to the Styx, serpentines and serpentinous schists are traversed to beyond Marlborough. The old Canoona gold diggings are in this serpentine.

A small belt of granite occurs at Marlborough itself. After passing over the serpentinous rocks, shales, belonging to the Permo-Carboniferous System, and dipping at highly inclined angles, are traversed as far as Stockyard Creek, at which place the Coal Measures rocks are first seen.

A Geological Map, on the scale of one inch to a mile, and one Plate of Sections, accompany this Report. Fig. 2 of the plate of sections is explanatory of the map.

The formations represented are:—

1. Recent Alluvium.
2. Recent or Post-Tertiary Conglomerate.
3. Desert Sandstone (Upper Cretaceous).
4. Mesozoic Coal Measures (Jurassic or Triassic).
5. Permo-Carboniferous Beds.

1. RECENT ALLUVIUM.

Patches of rich alluvial soil occur on either side of the Styx River. Portions of this ground are being used as agricultural farms. There are also extensive Marine Plains in the neighbourhood of the Styx River, and Waverley and St. Lawrence Creeks. These are coloured yellow on the map.

These Plains are generally well-grassed, but near their outer extremities they form large bare "salt pans." In some places on these Plains the underlying coal-measures come to within a few inches of the surface; while in others there is a deep deposit of alluvium. Mr. Christian, of Wilangi Station, pointed out the curious fact, that, where the surface of the salt pans shows ripple markings, the underlying rocks are almost sure to be close to the surface.

2. RECENT OR POST-TERTIARY CONGLOMERATE.

The "Divide" between the Fitzroy and Broad Sound Waters consists of a Tableland of about five miles in breadth, covered with a coarse conglomerate, which is probably of Post-Tertiary age. This conglomerate is shown in the south-east corner of the map. It consists of coarse pebbles of shale, sandstone, quartzite, and quartz. It overlies the Permo-Carboniferous rocks, which can be seen in the beds of some of the deepest gullies.

Conglomerates, of probably the same age, are to be seen overlying the Coal Measures on the margins of the marine plains in the neighbourhood of Foyle Park, and again overlying the Permo-Carboniferous rocks near Bridge Creek, Wilangi.

3. DESERT

3. DESERT SANDSTONE (UPPER CRETACEOUS).

Several small outliers of Desert Sandstone occur in the neighbourhood of Mamelon, Tooloombah, and Montrose Creeks. These rocks lie nearly horizontally, and overlie the Permo-Carboniferous rocks unconformably.

The summits of Mount Bison, Mount Mamelon, Mount Brunswick, and the two hills known as "The Sisters," are of this formation. The rocks consist of coarse white sandstone and conglomerates, with layers of white quartz pebbles. They are nearly horizontal, with, if anything, a slight dip towards the east. At the base of the Desert Sandstone on Mount Bison, and at the base of that near the junction of Mamelon and Tooloombah Creeks, there is a hard brown sandstone, containing the stem-markings of a plant, resembling the "*Calamites*" which I met with in the Desert Sandstone in White Mountain Creek, a tributary of the Flinders River.*

Desert Sandstone rocks occur also on ridges immediately east of Wilangi Station. Here they consist of white coarse sandstones, showing "false-bedding" in places, capped with magnesite rocks. They have a slight dip to the east. They appear to overlie the boundary line between the Mesozoic Coal-Measures and the Permo-Carboniferous rocks, as to the east of the ridge the outcrops of the former rocks are visible, while to the west the Permo-Carboniferous rocks crop out. The exact boundary line, however, is not by any means clearly defined, as the country on either side of the ridge is covered with a deep soil. The ridges run in a north and south direction for a distance of five or six miles.

Another area of Desert Sandstone is met with to the north of Waverley Creek, about two miles east of the town of Saint Lawrence. It extends in a north and south direction for a distance of nearly five miles, and averages about a mile in width. It consists of coarse sandstones with magnesite shales. At its eastern extremity it is about fifty feet thick, as shown by the shafts and boreholes which have been put down by the Broad Sound Coal Company through it into the Coal Measures rocks beneath.

4. MESOZOIC COAL MEASURES (JURASSIC OR TRIASSIC).

The Coal Measures cover an area of about twenty-six miles in length, in a north and south direction, with an average width of about six miles—about one hundred and fifty-six square miles in all. Their most southerly point is on Stockyard Creek, about twelve miles west-north-west of Marlborough Township, and they have been traced to a point two to three miles east of the Township of Saint Lawrence. The country over this area is generally flat, and is covered with deep soil and alluvium. Sections of the rock are almost entirely confined to the creeks which traverse the area.

With reference to the age of the Coal Measures, there is no evidence to show whether they are the equivalents of the Ipswich or the Burrum Beds. All that can be said with certainty is that they are Mesozoic. They are older than the Upper Cretaceous Desert Sandstone, by which they are overlaid unconformably, and newer than the Permo-Carboniferous rocks, in a depression of which they have been deposited, and on which they are resting unconformably.

I understand from Professor Edgeworth David, who spent some time in this district examining these beds, that *Tæniopteris* was met with in Mr. Christian's shaft in Foyle Park. I also found a few indistinct leaf-markings in shales in Foyle Park, but with those exceptions I believe no fossils have yet been found.†

Evidence of contemporaneous volcanic action is met with in shaft No. 5, Waverley Creek, (see Map), where fifty-seven and a-half feet of tuffaceous sandstone, containing white porphyritic particles, were passed through.

The thickness of these beds, in the neighbourhood of Tooloombah and Deep Creek, is 5,000 feet, taking their average dip at about 12 degrees, and their extent at right angles to the strike as being a little under five miles. In crossing the Coal Measures here I saw no sign of "folding" of the rock, causing their repetition. The sections in the creeks are sometimes so far apart that folding might occur in places, and not be seen at the surface.

The Coal Measures rocks at their western boundary overlie the Permo-carboniferous rocks unconformably. The boundary is clearly defined in Granite and Montrose Creeks. To the east they are thrown into contact with the Permo-Carboniferous rocks by a fault, running in nearly a north and south direction through Stockyard Creek, and passing somewhere near the mouth of Wellington Creek, and again near the Hoogly.

Two Companies have been started to prospect for coal in this "basin." The Styx River Coal Mining Company did some work in the neighbourhood of Tooloombah Creek, but have stopped operations owing to the distance from deep-water carriage. The Broad Sound Coal Company have been prospecting near the wharf on Waverley Creek, and hope shortly to start work on a seam they have discovered in a shaft within a quarter of a mile of the wharf.

The following are the details of the sections observed in the various creeks. Unfortunately they are very fragmentary, as they occur in many instances at long distances apart.

Stockyard Creek.—At the crossing of the Saint Lawrence road, brown calcareous sandstones, with thin layers of calcite, dip to the south at 14 degrees. A quarter of a mile further down the creek there are brown sandstones dipping a little north of east. This section is faulted by a small fault running north and south, with a downthrow to the east. Three hundred yards north-east of this section there are quartzites and shales of Permo-Carboniferous age dipping very steeply to the west.

Deep

* See Report on the Cape River Goldfield, by William H. Rands, Assistant Government Geologist, page 10. Brisbane: By Authority; 1891.

† In "The Geology and Palæontology of Queensland" (now in the press), by Mr. R. Etheridge, junr., and myself, Mr. Etheridge records the occurrence of *Phyllopteris Feistmanteli*, Eth. fil, from the Styx River Coal Shaft. The same plant occurs in the Ipswich Formation at Stewart's Creek, Rockhampton.—R. L. J.

Deep Creek.—The country is very flat between Deep Creek and Stockyard Creek. A short distance below the road there is a very dense scrub, which extends the whole way down the creek.

In the road cutting at the crossing of the creek the following section is exposed :—

	ft.	in.
Laminated brown sandstone	13	0
Band of calcite	0	0¼
Soft brown sandstone	4	0
Sandy shale	1	4
Hard sandstone (thickness unknown)		
	18	4¼

The dip is E. 13° N. at 13 degrees.

No other section is met with for a distance of nearly three miles down the creek, or a mile below the junction of Stockyard Creek, with the exception of a small outcrop of sandstone the dip of which could not be determined. At this point a brown sandstone dips east 30° north at 45 degrees; and a little further on a similar sandstone, nearly perpendicular, strikes north 35° west.

For a mile and a half below this point no further section is visible. Here a laminated calcareous sandstone dips north-east at 5 degrees.

Two hundred yards lower down, a hard brown sandstone dips north 50 degrees east at 8 degrees.

Three hundred yards lower down, again, brown sandstone dips north-east at 13 degrees.

About one hundred and fifty yards further down, finely laminated sandstone dips east 20 degrees north at 10 degrees.

In a gully running in a westerly direction into Deep Creek, about a quarter of a mile above Holt's shaft, the following section is visible :—

	ft.	in.
Brown clayey clod	2	3
Black coaly shale	0	4
Soft sandstone, with bands of clay	1	3
Black coaly shale	0	5
Blue clay shales	2	0
Hard sandstone	6	4
Coal (said to be 4 feet thick; only a few inches of it were above water)	4	0?
	16	7

The dip is east 20 degrees north at 10 degrees.

Fifty yards further down the gully, close to its mouth, and therefore on a lower horizon than the above, is a finely laminated sandstone, dipping, very flatly, a little north of east.

Holt's shaft, which is about a quarter of a mile below the gully, was sunk to a depth of thirty-five feet. After passing through the alluvial soil, shales with bands of nodular ironstone were met with. The shaft was abandoned owing to a great rush of water coming in.

A few yards below the shaft there is a small section :—

	ft.	in.
Laminated blue shales	4	0
Nodular sandstone	0	6
Clay	0	2
Coal	0	3
Laminated blue shales	3	0
	7	11

Dip E. 40 degrees N. at 15 degrees.

Two hundred yards further down, the following rocks dip west of north :—

	ft.	in.
Blue shale	1	0
Coal	0	7
Blue shale	0	11
Coal	1	6
Blue shales	2	1
Black coaly shale	1	4
Blue shales	5	0
No section (about 5 feet)	5	0
Coal	1	6
Blue shale	3	2
	22	1

About three hundred yards below this again is :—

	ft.	in.
Sandstone	0	5
Sandy shale	6	0
Black coaly shale	0	7
Blue shale	4	8
	11	8

A small fault occurs between the two last sections.

A hole was sunk in the shales in the bed of the creek, and I am informed a fine hard seam of coal, four feet in thickness, was struck. The whole was covered with water. The coal at the surface is hard, compact, and bright. The two following Analyses were made from different samples :—

	Analysis by R. Mar, Government Analyst.	Analysis by William H. Rands.
Moisture	1·90	1·75
Volatile Hydrocarbons	28·30	31·19
Fixed Carbon	64·56	60·36
Sulphur	0·81	0·40
Ash	4·43	6·30
	100·00	100·00

The

The ash is dark brown in colour. The coke is powdery and only slightly coherent. The specific gravity of the coal is 1·30. The coal may be classed as free-burning bituminous. The percentage of ash is low.

About a quarter of a mile below this, there is a section of calcareous sandstone dipping north 30 degrees east at 10 degrees.

In the Styx River, at the confluence of Tooloombah and Deep Creeks, about one-third of a mile further down, thick beds of a flaggy carbonaceous sandstone dip east at 20 degrees north at 10 degrees.

Dense scrub occurs on either side of the creek, and extends for a mile and a-half to the east of the creek. Outside the scrub is the hard quartzite of the Permo-Carboniferous rocks.

Tooloombah Creek.—The Coal Measures are first seen in this creek, near the crossing of the telegraph line, south-east of Mount Brunswick, and about half-a-mile below the junction of Mamelon Creek, where a coarse sandstone dips east 15 degrees north at from 8 to 10 degrees.

About three-quarters of a mile down the creek, a shaft was sunk, near the bank, to a depth of seventy-four feet, by the Styx River Coal Mining Company. The following section of the strata passed through in the shaft was given me by Mr. Cochrane, who superintended the sinking. I could not examine the shaft myself as it was half full of water:—

	ft.	in.
Alluvial	43	0
Yellow and blue shale	5	0
Black shale	0	6
Tough black shale	2	6
Blue shale	3	0
Dark sandstone, with thin coal	2	0
Hard blue rock	0	6
Tough blue shale, showing prints of leaves, and flakes of coal	4	0
Coal	2	7
Blue shales	0	6
Black shales, with flakes of coal	3	0
Coal	0	6
Dark coloured sandstone	1	0
Black shales, showing flakes of coal	2	0
	70	1

Three boreholes were also put down in the neighbourhood of this shaft. No. 1 is seventeen chains north-east of the shaft. It passed through:—

	ft.	in.
Sandy soil	5	0
Boulder drift	12	0
Soft sandstone	4	3
Hard sandstone	8	0
	29	3

No. 2 Bore is forty-seven chains north-east of the shaft. It gave the following section:—

	ft.	in.
Yellow clay	9	0
Sandy drift	5	3
Hard conglomerate	11	9
Gypseous clay	9	0
Indurated clays	10	7
Ironstone bands and flinty sandstones	12	0
Black clod, and fragments of coal	7	9
Soft shale	4	0
Tough blue shale	60	0
Soft shale with specks of coal	12	7
	141	11

No. 3 Bore is about three chains east of the shaft:—

	ft.	in.
Black soil	5	4
Yellow clay with hard pebbles	10	3
Fine drift with nodules of ironstone	12	0
Large boulder drift	2	6
Decomposed sandstone	8	3
Hard sandstone	10	4
Shingly drift	4	6
Soft sandstone	5	2
Hard shale, with alternate clay and ironstone bands, and two one-inch beds of *coal*	6	0
Hard sandstone with one inch of *coal*	8	3
Shale with hard ironstone bands	12	3
Hard gypseous marls	2	2
Hard marls	23	3
Coal	0	10
Coaly shale	8	6
Indurated gypseous clays	12	4
Shale	12	0
Clod, and fragments of coal	8	0
Shingly drift	0	2
Soft shale	3	2
Tough shale	4	3
	159	6

The

The following section is visible in the bank of the creek opposite the shaft:—

	ft.	in.
White and bluff-coloured clay with calcareous sandstone	3	6
Hard brown sandstone	0	1½
Thin laminated shales	1	6
Coarse sandstone	0	1
Sandy shales	0	11
Hard brown carbonaceous sandstone	0	7
Laminated soft sandstone and sandy shales	1	6
Hard coarse sandstone	2	0
Sandy shales, and blue clay shales	9	0
Coal	0	6
Blue clay shales	4	1
Coal (under water, said to be between four and five feet thick).		
	23	9½

Dip of strata E. 30° N. at 13 degrees.

I broke some pieces of coal off from the seam under water, and it appeared to be of good quality.

The boreholes Nos. 1 and 2 were not deep enough to cut the seam of coal met with in the shaft. In No. 1 borehole this seam should be at a depth of about four hundred feet; and in No. 2 at about seven hundred and fifty feet. In No. 3 borehole the 2 ft. 7 inch seam of coal should have been struck at about one hundred and twelve feet in depth. At about that depth a seam of coal ten inches thick is reported. Whether this is the same seam or not is uncertain. The boring was done with "jumping rods," and the material would come up in the state of powder, and there may, therefore, be some mistake as to the thickness.

The shaft was abandoned on account of the quantity of water, there being no pumping machinery to keep it down. There was only from ten to fifteen feet of water in the shaft, however, at the time of my visit. The following are Analyses of the coal from the shaft:—

—	By Dr. J. Storer, Sydney.	By the late Mr. E. B. Lindon.	By Mr. F. W. Martin, Rockhampton.	By William H. Rands.
Moisture	2·08	2·20	2·00	1·33
Volatile Hydrocarbons	29·68	31·30	30·90	30·05
Fixed Carbon	62·66	62·60	62·90	64·96
Sulphur	not detd.	not detd.	nil.	0·26
Ash...	5·58	3·90	4·40	3·40
	100·00	100 00	100·20	100·00

The ash is light yellow in colour. The coke was not very coherent. The coal is fairly hard and firm. A Report by Mr. F. Linthwaite, Locomotive Foreman, Central Railway, is appended.

Very few sections are visible in the creek below the shaft. The first is about a mile and a quarter down, where sandstone and shales dip east 30° North at 12 degrees.

A quarter of a mile further down there are:—

	ft.	in.
Thick-bedded sandstone, with bands of nodular sandstone	18	0
Coal	0	6
Shale	1	3
	19	9

Dip east at 10 degrees.

About three hundred yards further down, and on the north side of the creek, twenty-five feet of coarse thick-bedded sandstone is visible in the bank of the creek. Dip east at 10 degrees.

About a quarter of a mile further down, again, there is a similar sandstone, twenty feet thick, dipping east 25 degrees north at 13 degrees; and half a mile further down, a similar sandstone dips in the same direction. From this point to the Styx River there is a high bank of recent alluvium.

Styx River.—At the junction of Tooloombah and Deep Creeks, flaggy sandstones dip east 20 degrees north at 10 degrees. No section of any consequence occurs for a distance of three and a half-miles.

At the crossing of the road opposite Beardmore's Farm, thin-bedded and flaggy sandstones, fifteen feet thick, dip east 20 degrees north at 8 degrees. This sandstone contains fossilised wood.

In a gully about three quarters of a mile north-north-east of this, a thick-bedded sandstone dips east 25 degrees north at 13 degrees. A little lower down, in the bend of the river, alternate thick and thin bedded sandstones, twenty feet thick, overlying blue shales, dip east 20 degrees north at 8 degrees.

About 2½ miles below this there is a thick-bedded brown sandstone dipping east 30 degrees north at 14 degrees. Below this, again, there are large alluvial flats, and no sections occur.

Montrose Creek.—Following up Montrose Creek from the Styx River, alluvial flats occur on both banks for about a mile.

About half a mile above "Beardmore's Farm" laminated sandstone and blue shales dip to the south at 10 degrees. These rocks undulate for a distance of sixty yards. At that point they dip north 30 degrees east at five degrees. They then lie horizontally for a short distance, and afterwards bend gradually round until they dip east 10 degrees north at 8 degrees. The section consists of:—

	ft.	in.
Laminated sandstone	10	0
Soft yellow sandstone	2	0
Blue shales	6	0
	18	0

One hundred and fifty yards higher up the creek a hard sandstone dips east 20 degrees north at 14 degrees. One hundred yards beyond this, brown sandstone dips east 20 degrees north at 8 degrees.

Only a short distance above this a hardened altered sandstone dips east at 32 degrees. This sandstone belongs to the Permo-carboniferous Series.

Granite Creek.—In a gully running into Granite Creek, close to the crossing of the lower Wilangi Road, alternate sandstones and shales dip east 15 degrees north at 20 degrees. Half a mile, or less, above this the Permo-Carboniferous rocks can be seen dipping north-east at 33 degrees.

Wilangi.—In Kanaka Creek, east of Wilangi Station, a calcareous sandstone dips a little north of east at 8 degrees.

In Selection No. 188, about three miles east of the Station, a reddish brown carbonaceous sandstone dips east 10° south at 15 degrees. This is overlaid, a little higher up the gully, by a white fireclay about a foot in thickness.

About three hundred yards from the north-west corner-peg of Selection No. 78, a reddish brown carbonaceous sandstone occurs about six inches below the surface, dipping north-east.

A dark brown carbonaceous shale, containing indistinct plant-markings, occurs in a creek, running in a north-east direction into Foyle Park Plain, about a mile and a half north-east of Wilangi Station. Dip north 35° east at 18 degrees.

Mr. Christian, Manager of Wilangi Station, to whom I was much indebted for his kindness in conducting me over the run, sank a shaft in search of coal on Foyle Park, about seven miles north-east of the Station. It was put down to a depth of one hundred and fifty feet, and passed through five small layers of coal, the thickest of which was only two inches. The strata in the shaft were said to be dipping in a direction somewhat west of south. If this was so there must be some fault or disturbance between the shaft and the edge of the plain, not one hundred yards distant, as there the rocks have the regular north-easterly dip. I could not see anything of the shaft, as it was timbered and partly full of water, and no record appears to have been kept of the strata passed through.

Several sections are visible in the rising ground along the margin of the plain.

One hundred yards north-west of the shaft thick-bedded carbonaceous sandstone dips north-east at 20 degrees.

North of the shaft, about three hundred yards, is the following section, dipping in the same direction:—

	ft.	in.
Soft laminated sandstone	2	6
Hard brown sandstone	1	0
Coarse reddish sandstone	1	0
Laminated sandstone	1	9
	6	3

Half a mile west of the shaft, shales and sandstone dip a little north of east at 7 degrees.

One and half miles north-east of the shaft a carbonaceous sandstone and conglomerate dip east 15° north at 40 degrees; and are overlaid by a conglomerate, probably of Post-Tertiary Age.

One and a half miles north 7° west of this point, a small anticlinal axis occurs, running in a north-north-west direction. Beds of sandstone, with alternate thin shales, over four hundred and ten feet in thickness, are visible on the plain to the east of this anticlinal, dipping east 25° north at 23 degrees. These rocks are shifted about six feet, by a fault running in an east-north-east direction, with a south-south-west downthrow.

On the "Home Plain," about a mile and a half east-south-east of the above, reddish sandstones, dipping south 38° west, occur, and are slightly disturbed by a "trough fault."

About a mile and a half east of this, the Permo-Carboniferous rocks occur, thrown against the Coal Measures by the continuation of the large fault which runs by Stockyard Creek, and near the mouth of Stoodleigh Creek.

No coal has yet been discovered on the Wilangi Run. It is probable that the coal would be at a great depth in the position of the shaft on Foyle Park. The seam struck in the Styx River Company's shaft, on Tooloombah Creek, should crop out somewhere far to the west of the Foyle Park shaft. A few boreholes put down in positions at right angles to the "strike" of the strata—that is to say, in a line about east 20° north, and starting immediately to the east of the "Desert Sandstone" Ridge, would probably discover that seam.

Waverley Creek.—Nothing further can be seen of the Coal Measures north of the above sections, as the country consists of alluvial plains as far as Waverley Creek, and north of that creek the Coal Measures are covered partly by alluvial plains, and partly by the Desert Sandstone. All that is known concerning those beds has been found out by boring and sinking in the locality of the wharf on the north side of Waverley Creek. The prospecting here has been done by the Broadsound Coal Company, under the direction of Professor Edgeworth David, and under the local management of Mr. R. Davidson.

The following particulars of the shafts and bore-holes were kindly given to me by Professor David:—

Shaft No. 1 is situated about a quarter of a mile north-west of the wharf. The shaft was sunk to a depth of ninety-six feet, and then a borehole was put down for a further depth of eighty-four feet, making one hundred and eighty feet in all. The section was as follows:—

		ft.	in.	
Magnesite shales, somewhat sandy, and ironstained near the surface	Desert Sandstone	48	0	
Ferruginous shales	Desert Sandstone	0	3	
Pale greenish-grey shales		43	9	
Dark gray clay shales, with thin seams of coal and fossil leaves		6	0	
Coal (upper 6 inches good hard bituminous coal, the lower 9 inches a splint coal, impure in places)		1	3	Borehole.
Light and dark grey sandy shales		20	9	
Coal, hard bituminous		1	3	
Band of soft clay shale		0	8	
Coal, hard bituminous and splint		2	0	
Band of soft clay		1	4	
Coal		1	8	
Light and dark grey sandy shales to bottom		53	1	
		180	0	

The

The following are Analyses of the coal from the 15-inch seam at a depth of ninety-eight feet :—

	By Dr. Helms.	By Mr. R. Mar.		By W. H. Rands.
		Sample I.	Sample II.	
Moisture	2·57	2·00	1·50	1·75
Volatile Hydrocarbons	27·39	28·63	26·19	28·86
Fixed Carbon	63·15	66·88	66·00	66·76
Sulphur	0·80	0·86	0·70	0·63
Ash	6·09	1·63	5·61	2·00
	100·00	100·00	100·00	100·00

The ash is yellowish brown. The coke is powdery and only slightly coherent. The specific gravity of the coal according to Dr. Helms is 1·341.

The following are Analyses of the bands in the 6 feet 11 inch seam, by Dr. Helms :—

	Top Seam.	Middle and Bottom Seam.
Moisture	2·58	2 17
Volatile Hydrocarbons	21·58	24·18
Fixed Carbon	63·82	62·40
Sulphur	0·51	0·60
Ash	11·51	10·05
	100·00	100·00

The specific gravity of the coal from the top seam was 1·398 ; of that from the bottom seam 1·365.

The dip of the strata in this shaft is south-east at 10 degrees.

Shaft No. 7 was one hundred and twelve feet in depth when the influx of water caused the necessity for boring. It is only forty feet north of No. 1 shaft. The fifteen-inch seam was struck at ninety feet in depth. A tube eight inches in diameter was driven through the thick seam from the bottom of the shaft, and the core raised. The core, although broken, fairly bore out the measurements obtained in Shaft No. 1. Samples from this core were selected for analysis by Dr. John Storer, who reported as follows:—

	Top Seam.	Middle Seam.	Bottom Seam.
Volatile Hydrocarbons	28·05	30·35	30·25
Fixed Carbon	59·70	60·15	57·00
Ash	12·25	9·50	12·75
	100·00	100·00	100·00
Ash	White and flocculent	White	White and flocculent
Coke	Firm	Firm	Firm

Shaft No. 6 is one hundred and ten yards west 12 degrees north of Shaft No. 1. It was sunk to a depth of one hundred feet, and a bore was put down at the bottom to a further depth of thirty-seven feet, making the total depth one hundred and thirty-seven feet. The section was as follows :—

	ft.	in.
Magnesites and sandstone (Desert Sandstone)	47	0
Light and dark grey sandy shales	90	0
	137	0

No. 4 *Borehole* is situated between Shafts Nos. 1 and 6. It gave the following section :—

	ft.	in.
Magnesites and sandstone (Desert Sandstone)	50	0
Grey sandy clay shales	18	0
Perished coal	0	6
Light and dark grey shales	21	6
Coal, and clay shale	0	3
Alternate light and dark grey shales	16	9
	107	0

It will be evident on comparing Shaft No. 6 and Borehole No. 4 with Shaft No. 1 that a fault must occur between them, as in the Borehole only the upper seam, somewhat disturbed, is struck, and then the shales immediately underlying the lower seam occur. The lower thick seam, 6 feet 11 inches in thickness, containing 4 feet 11 inches of coal, is missing. In the shaft the lower seam is not met with. The dip being south-east at 10 degrees, it would have been passed through. The Diagram. Fig. 1 of the plate of sections, explains this more clearly :—

Borehole No. 2 is situated about thirty chains west-north-west of shaft No. 1. It passed through:—

	ft.	in.
Magnesites, &c. (Desert Sandstone)	50	0
Shaly strata	35	0
Dark grey clay shale	11	0
Hard sandy clay shale	19	0
Greenish sandy clay	11	0
Dark grey coaly shale with fragments of bituminous coal, and white fireclay	0	10
Dark clay shale	2	2
White fireclay	14	0
Greenish grey fine sandy shale, with a little coal	10	0
Stiff soapy grey shale	4	0
Pale grey sandy clay shale	5	0
Dark grey shale, with clay partings	5	0
Greenish grey clay shale, with streaks of coal	8	0
Dark grey sandy clay shale	12	0
Carbonaceous grey sandy shale	5	0
Greenish grey sandy clay shale	8	9
Concretionary ironstone	1	3
	202	0

Borehole

Borehole No. 5 is situated a few chains to the north of shaft No. 7. It passed through :—

	ft.	in.
Desert Sandstone rocks	54	0
Clay shales	2	6
Carbonaceous clay shale, with perished coal	0	3
Alternate light and dark grey shales	58	9
	115	6

Shaft No. 5 is situated on the plain nearly two and a-half miles north 22 degrees east of Shaft No. 1. It gave the following section :—

	ft.	in.
Dark grey estuarine clays	15	0
Estuarine sand, with layers of from ½-inch to 2 inches cemented by lime of dissolved shells, and containing fragments of recent marine shells ...	50	0
Tuffaceous sandstone, with a number of white porphyritic particles	57	6
Coaly sandy shale, with streaks of coal of from ⅛-inch to ½-inch in thickness ...	1	0
Sandstone with particles of coal	11	6
	135	0

Shafts Nos. 2 *and* 3 were sunk on the plain to the depth of a few feet only. They were abandoned owing to running sand being met with; and shaft No. 4, the site for which was chosen, was not started as similar conditions were anticipated.

QUALITY AND ECONOMIC VALUE OF THE COAL SEAMS.

The following is a short *résumé* of what has already been said as to the quality of the coal.

The Styx River Coal Company's Seam, Tooloombah Creek is two feet seven inches in thickness. It is a hard coal, somewhat laminated, the layers being alternately bright and dull in lustre. It is jointed at right angles to the bedding. It burns freely in an open fire, leaving a nearly white ash. The specific gravity of the coal is 1·318. The coke was not very coherent. It takes a polish under the knife. The ash is very low, the average percentage of four analyses being only 4·32.

The Deep Creek Coal Seam is a hard, compact and bright coal. It is slightly laminated in parts. It is reported to be four feet thick. It is a free burning bituminous coal. The coke is only slightly coherent. It has a low percentage of ash. The specific gravity of the coal is 1·30.

The above seams are unfortunately situated at a long distance from water carriage. A tramway of at least eighteen to twenty miles would have to be constructed to carry the coal to deep water on the Styx River.

Broad Sound Coal Company's Seams.—The Upper or Fifteen-inch Seam is a good hard coal, the upper six inches of which are bituminous, the lower nine inches being splint coal. It has a bright lustre. Its specific gravity is 1·14. The percentage of ash is low.

I have not seen samples of the Lower, or Thick Seam.

For convenience sake I give the Analyses of the different coals in a tabulated form.

	Authority.	Moisture.	Volatile Hydro-carbons.	Fixed Carbon.	Sulphur.	Ash.	Sp. Gr.
Deep Creek Seam	R. Mar ...	1·90	28·30	64·56	0·81	4·43	1·280
	W. H. Rands	1·75	31·19	63·36	0·40	6·30	1·298
Styx River Coal Company's Seam... ...	Dr. Storer ...	2·08	29·68	62·66	...	5·58	1·318
	E. B. Lindon	2·20	31·30	62·60	...	3·90	
	F. W. Martin	2·00	30·90	62·90	nil	4·40	
	W. H. Rands	1·30	30·05	64·06	0·26	3·40	
Broad Sound Coal Company — Fifteen-inch Seam... ...	Dr. Helms	2·57	27·39	63·15	0·80	6·09	1·341
	R. Mar ...	2·00	28·63	66·88	0·86	1·63	
	R. Mar ...	1·50	26·19	66·00	0·70	5·61	
	W. H. Rands	1·75	28·86	66·76	0·63	2·00	
Broad Sound Coal Company — Thick Seam — Top Band	Dr. Helms ...	2·58	21·58	63·82	0·51	11·51	
Thick Seam — Top Band ,,	Dr. Storer ...	...	28·05	59·70	...	12·25	
Thick Seam — Middle and Bottom Band	Dr. Helms ...	2·17	24·18	62·40	0·60	10·05	
Thick Seam — Middle Band	Dr. Storer ...	...	30·35	60·15	...	9·50	
Thick Seam — Bottom Band	Dr. Storer ...	...	30·25	57·00	...	12·75	

5. PERMO-CARBONIFEROUS BEDS.

The greater part of the district is made up of these Beds, and the Coal Measures are completely surrounded by them.

The rocks of this formation consist chiefly of indurated shales, mudstones, sandstones, conglomerates, quartzites, and greywackes. One thin bed of fossiliferous limestone occurs to the north of Granite Creek. The general strike of the beds is about north-north-west.

Travelling along the Saint Lawrence Road from Marlborough, and after passing the dividing ridge between the Fitzroy and Broad Sound Waters, several outcrops of a hardened blue shale, dipping very steeply in a westerly direction, are seen. A little to the north of the road, close to Stockyard Creek, and also along the Stoodleigh road, quartzites, dipping in the same direction, occur. These quartzites are separated from the Coal Measures, a few yards to the west, by the north and south fault before alluded to.

In Stoodleigh Creek, about half a mile north-north-east of the Station, there are beds of a hard sandstone and greywacke, which dip nearly perpendicularly, and strike north 50° west. About two miles lower down the same creek, in segregation-nodules in a hard blue sandstone, I found two fossils—viz., a species of *Sanguinolites*, and a species of *Mœonia*. The former is identical with the species of *Sanguinolites** occurring in the Gympie Beds. The sandstone is dipping steeply south-west.

To

* Determined by Mr. R. Etheridge, Junr., to be *Sanguinolites concentricus*, Eth.—R. L. J.

To the east of these sections, in Wellington Creek, alternate hard sandstones and indurated shales dip north-north-east steeply, an anticlinal axis occurring between the two creeks. Higher up the creek, again, similar rocks, dipping the same way, overlie some serpentinous shales.

On the western side of the Coal Measures, in Mamelon Creek, a little above its junction with Tooloombah Creek, indurated shales and sandstones dip steeply to the east; until, at the crossing of the Saint Lawrence Road, there is an anticlinal curve, and above that the shales are dipping to the west.

On the south-west slope of Mount Brunswick, in similar shales and sandstone, I discovered some Permo-Carboniferous fossils. These have been sent to Mr. R. Etheridge, Junr., Palæontologist to the New South Wales Geological Survey, for identification. I have not yet received his notes on them, and a full list of them will be published hereafter. They include the following genera :—

PELECYPODA.

Aphanaia, sp. (in large numbers).
Productus, sp.

GASTEROPODA.

Pleurotomaria Carinata?, Sby.

CEPHALOPODA.

Nautilus, sp.

This is, I believe, the first occurrence of the genus *Aphanaia* recorded in Queensland. Species of this genus have been found in both the Upper and Lower Marine Series of the Lower Coal Measures of New South Wales at Glendon, Wollongong, Muree, Branxton, and Anvil Creek. The Lower Coal Measures of New South Wales are classed as Upper Carboniferous.

Several sections of the same rocks are visible for some miles up Tooloombah Creek.

In Montrose and Granite Creeks, numerous sections of the same sandstones and indurated shales are visible, with a general dip to the north-east. At the foot of Connor's Range, altered greywackes occur. North of Granite Creek about two miles west-north-west of the road crossing, and in selection No. 88, alternate sandstones, shales, and conglomerate, with a bed of limestone, occur, dipping east at 8 degrees. In the limestone, and in the sandstone underlying it, there are numerous Permo-Carboniferous fossils, a collection of which have been sent to Mr. R. Etheridge, Junr., whose notes I have not yet received. In the meantime I publish the following list :—

ANNELIDA.—

Spirorbis, sp.

POLYZOA.—

Fenestella, sp.
Protoretepora, sp.

BRACHIOPODA.—

Productus brachythærus, Morris.
" *semireticulatus*.
" sp.
Spirifera bisulcata, Sby.
" sp.

PELECYPODA.—

Aviculopecten squamuliferus, Morris.
" sp.
Pecten, sp.

GASTEROPODA.

Pleurotomaria, sp.

About a mile north-north-west of Waverley Station, there is a bed of dark crystalline limestone; and north of this, again, on the ridge between Saint Lawrence and the wharf on Waverley Creek, there are grits and sandstones with interbedded felstones, dipping in a westerly direction.

About two and a-half miles north of this, again, near the edge of the plain, there is a coarse grit which could easily have been mistaken for the Desert Sandstone, which occurs on other portions of the same ridge, had it not contained Corals, and casts of *Spirifera*, and other Permo-Carboniferous forms. On Saint Lawrence Creek, about four miles above from the township, hardened sandstone, sandy shales, and greywackes dip north-north-west at twenty-five degrees.

Before concluding this Report, I must allude to Langdale Hill, about two-thirds of a mile south 30 degrees east of Tooloombah Station. This hill consists of a white porphyry, intrusive in the Permo-Carboniferous rocks. The porphyry consists of a white felspar, with blebs of clear glassy quartz. It contains numerous small specks of iron pyrites. A few veins of hard bluish quartz run through it. This stone was worked for gold some two or three years ago. A bag of the stone was sent to Melbourne for treatment and yielded gold at the rate of 1 oz. 17dwts. per ton; but afterwards on four tons of similar stone being sent to Melbourne, the yield was only 4 dwts. The stone does not look at all a likely one to contain any quantity of gold, though there might be a little of the precious metal in the small quartz veins, leading to the belief that the entire mass of rock was gold-bearing. Langdale Hill is covered with a dense scrub. Its summit is about three hundred feet above the level of Tooloombah Station.

The ridges one mile south-west of the station are also of porphyry.

WILLIAM H. RANDS,
Assistant Government Geologist.

APPENDIX.

APPENDIX.

Report by Mr. F. Linthwaite, Locomotive Superintendent of the Queensland Central Railway, upon the Quality of Styx River Coal Mining Company's Coal.

Central Railway, Rockhampton, July 9th, 1889.

The Commissioner for Railways, Brisbane:—

Trial of Test Coal—local product—Styx River.

I have the honour to advise that at the request of Mr. James Stewart, of Messrs. James Stewart and Company, representing the parties interested in the development of the Coalfield on the Styx River, I accepted 4 tons 1 cwt. of the coal for a trial test as to its steaming and heating qualities, and its general adaptability or otherwise for use in the locomotive engines on the Central Railway.

The conditions on which I accepted the coal for a trial test were that, on completion of the trial, my Report was to be sent direct to you, and that no information was to be sought from me as to its steaming, &c., qualities, pending the receipt of advice from your office. Therefore, these conditions being agreed to, I arranged with the Traffic Manager for a full train load of not less than 125 tons. On the 1st instant, accompanied by the Traffic Manager, I left Rockhampton with No. 37 Dub's F class 13 in. cylinder engine, driver C. Gill, with a rolling load behind tender of 126 tons. We accompanied the trial load right through to Barcaldine and back, so as to closely watch the consumption and steaming qualities of the coal, and I must certainly say that a better sample of coal has not been used on this line. When ascending the long 1 in 50 grades to Westwood, a splendid head of steam was kept up, although one injector was frequently put on to keep a full supply of water in the boiler; and on arriving at Westwood, I had the smoke-box door opened, and was surprised at the small quantity of ash to be found therein, also the small quantity of ash to be found in the fire-box and ash-pan. With the gentle use of the shaker bars what ashes were on the fire-box broke up and fell into the ash-pan, and there were no clinkers to pick off the fire-bars in the fire-box. Thereby a splendid fire was easily kept up, and the pricker was never used to the fire-rod through the journey, which seemed a surprise both to the engineman and fireman, who kept constantly speaking to me of the splendid steaming qualities of the coal they had that trip, and the little trouble it gave them to keep up a full head of steam. After the shunting was done at Emerald, and the men had had their supper, the ashes were cleaned out of the smoke-box, and they nearly filled one bag. Then the ashes were taken out of the ash-pan and fire-bed, and they filled two bags, and their respective weights were taken, *vide* attached statement, which gives total consumption, mileage run, and tonnage through from Rockhampton to Barcaldine, and back to Alice. As you are well aware, there are many steep up grades of 1 in 40 and 1 in 30 between Emerald and Bogantungan, and the Drummond Range, also from there to Barcaldine. All the grades cause a very large consumption of fuel. Frequently as high as 32lbs. per mile is consumed of the Brisbane coal when working a 70 ton train load behind a tender over the Drummond Range with Dub's 13in. cylinder engine. My only regret is that these new coal fields are not at present sufficiently opened out to provide a supply for the use of all engines running on this line. Another remarkable feature in connection with this coal is that it emits far less smoke than any other Queensland product. It is therefore especially suitable for use on passenger engines.

F. LINTHWAITE,
Locomotive Foreman.

Queensland Central Railway, Locomotive Department, Rockhampton, July 6, 1889. Report to Locomotive Foreman of Unusual Occurrence, Engine No. 37. Train Notice 6, July 1st, 1889. *Re* Trial of Coal.

Sir,—I have the honour to report that I found this coal to be very good for steam raising. It is very easy to work, and very clean, making very little ashes. In fact I consider it equal to any Newcastle coal that we have been supplied with.

	FIRST DAY. tons cwt. qr. lbs.				SECOND DAY. tons cwt. qr. lbs.			
Weight of train	126	0	0	0	...	*		
Coal	† 4	1	0	0	...			
Ashes in fire-box and ash-pan	0	2	3	0	...	0	3	0 26
Ashes in smoke-box	0	1	1	7	...	0	1	0 5
Miles run...		165			...		225	

The run was 390 miles. In addition to the above, there was the necessary shunting to be done at the commencing and concluding of each day's run.—C. Gill, Engineman.

Average consumption, 23·030 lbs. of coal to the mile, Rockhampton to Barcaldine, thence to Alice: in all 390 miles.—Say 23⅓ lbs. to the mile.—F.L.

---

* Weight of train on second day—To Bogantungan, 86 tons; to Barcaldine 69 tons; Barcaldine to Alice, 60 tons.
† This is the total quantity of coal used on both days.

Price 1*s*.]

By Authority: James C. Beal, Government Printer, William street, Brisbane.

GEOLOGICAL MAP of the STYX RIVER COALFIELD

To accompany report on the Styx River Coalfield

BY
WILLIAM. H. RANDS, F.G.S.
Assistant Government Geologist

1892

— Scale 1 Mile to the inch —

PRINTED, AT THE GOVT. ENGRAVING, & LITHOGRAPHIC OFFICE BRISBANE, QUEENSLAND

BROAD SOUND

THE HOOGLY

Marine Plain

Creek

St. Lawrence

Mangroves

Seaview Hill

Sandstone & Greywacke

St. Lawrence

Basalt

Dark colored Crystalline Limestone

Waverley Hd Stn

Lagoon

64

Swampy Plain

Waverley Ck

"Foyle Park"

Waverley

Creek

WHARF

Dark carbonaceous shales Cont'g indistinct Plant markings

Sandstone, Dip unascertain

Marine Plain

"Home Plain"

78

75

74

80

87

88

178

Wilangi Hd Stn

RES.

Amity

Granite

Creek

Hard Greywacke

Coarse conglomerate

Indurated shales & coarse sandstone

Shales and sandstone

Indurated shales & sandstone

Conglomerate sandstone & shales

Sandstone and indurated shales

Sandstone

Lower Marine Series

Alternate sandstone & shales

Sandstone and indurated shales

Slates & Sandstone

Syncline

Fault

Creek

Hard sandstone

Bed sandstone indurated & Greywacke shales

Hard grey sandstone

Greywacke

Altered semi-crystalline Greywacke

Campbells Range (Low elevated ridges)

Mt Brunswick

Indurated shales & sandstone containing Permo-Carboniferous Fossils

Dip unascertain

Creek

Sandstone

Shaft 160 ft deep

Mt Mamelon

Indurated shales

Blue indurated shales and Quartzite

Mt Bison

Horizontal sandstone containing stem markings of Plants at base

Blue indurated shales

Tooloombah

Tooloombah Hd Stn

Langdale Hill

Quartz Porphyry

Sarsfield Ck

Magorten Ck

Tavour Ck

Mameloon or Dragoal Ck

Deep Ck

654

TOWN RES.

Indurated shales

Blue indurated shales and Quartzite

Tableland of coarse Recent or Post-Tertiary conglomerate overlying the Permo-Carboniferous Beds, which are seen in the deeper gullies

Indurated shales

Blue Shales

ROAD TO ROCKHAMPTON

STOODLEIGH ROAD

Stoodleigh Hd Stn

Brown Calcareous Sandstone

Brown sandstone

Indurated brown sandstone & shale

Quartzite & indurated shales

Black carbonaceous shales sandstone & coal reported to be 4' thick

Thick bedded sandstone

Thick calcareous sandstone & shale

Thick bedded sandstone

Thin bedded sandstone

Thick-bedded sandstone nodular in parts 8 Coal 6' thick

Brown sandstone

Sandstone

Quartzite

Stockyard Creek

Paddock

RES.

Leminated Brown sandstone with band of shale

Alternate beds of hard sandstone & indurated shales overlying an altered serpentinous rock

Hard dark colored sandstone containing "sanguinolites"

Serpentinous rock

Altered calcareous sandstone

Creek

Wellington

Dense Brigalow Scrub

Dense Vine Scrub

Stoodleigh

Styx River

Styx

Fault with downthrow to the West

Sandstone

Brown Sandstone

Thin bedded sandstone

Thick bedded sandstone

Thick & thin bedded sandstone

Brown sandstone

Sandstone

Brown Sandstone

Thick & thin bedded sandstone

Thick flaggy sandstone

Brown Calcareous sandstone

Beds of sandy shale & shaly sandstone & 4 seams of Coal

Shales & sandy shales & 1 Th. Coal

Holt's Shaft

Brown sandstone

Laminated brown sandstone & shale

Black carbonaceous shales sandstone & coal reported to be 4' thick

Quartzite & indurated shales

Brown sandstone

Sandstone

Quartzite

Beardmore's Farm

Thin bedded flaggy sandstone containing fossilized wood

Alternate sandstone and shale

Sandstone

Shales & Sandstone

Alternate sandstone & shales

Sandstone and indurated shales

Conglomeratic sandstone

Coarse brown sandstone

Indurated shales

Sandstone

Shales

Bed of brown Sandstone at the base of the Desert Sandstone Contains stem markings of Plants

Sandstone

Shales

Sandstone

Indurated shales & sandstone containing Permo-Carboniferous Fossils

Dip unascertain

Creek

Sandstone

Shaft 160 ft deep

Sandstone

Brown Sandstone

Sandstone

Brown Sandstone

Sandstone

Quartzite

Sandstone

Brown Sandstone

Sandstone

Brown Sandstone

Sandstone

Quartzite

Sandstone

Brown Sandstone

Sandstone

Quartzite

Sandstone

Brown Sandstone

Sandstone

Quartzite

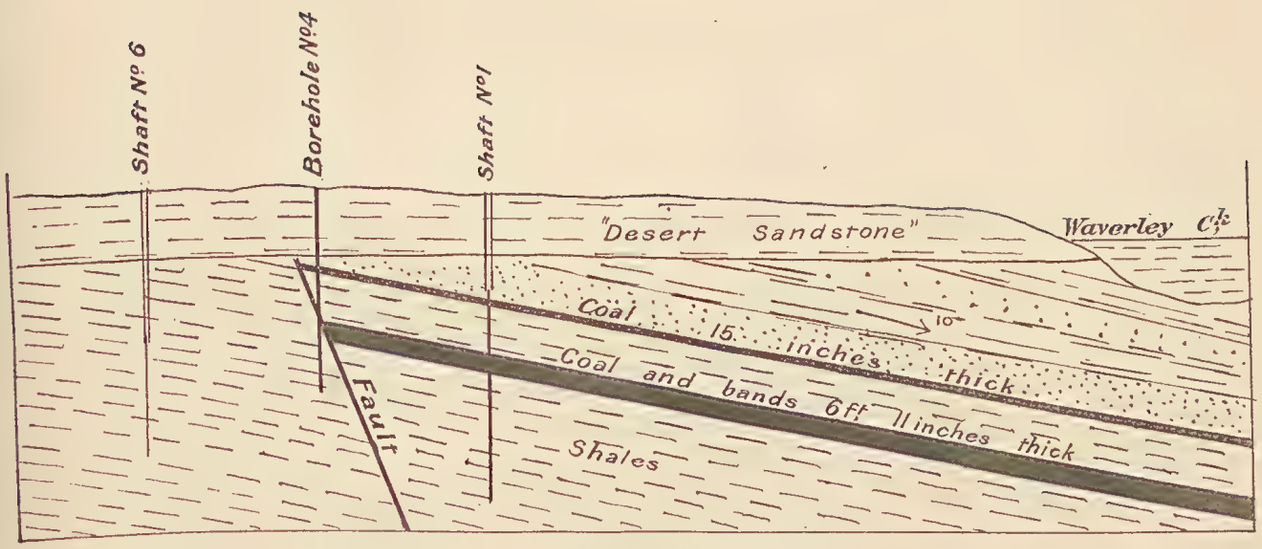
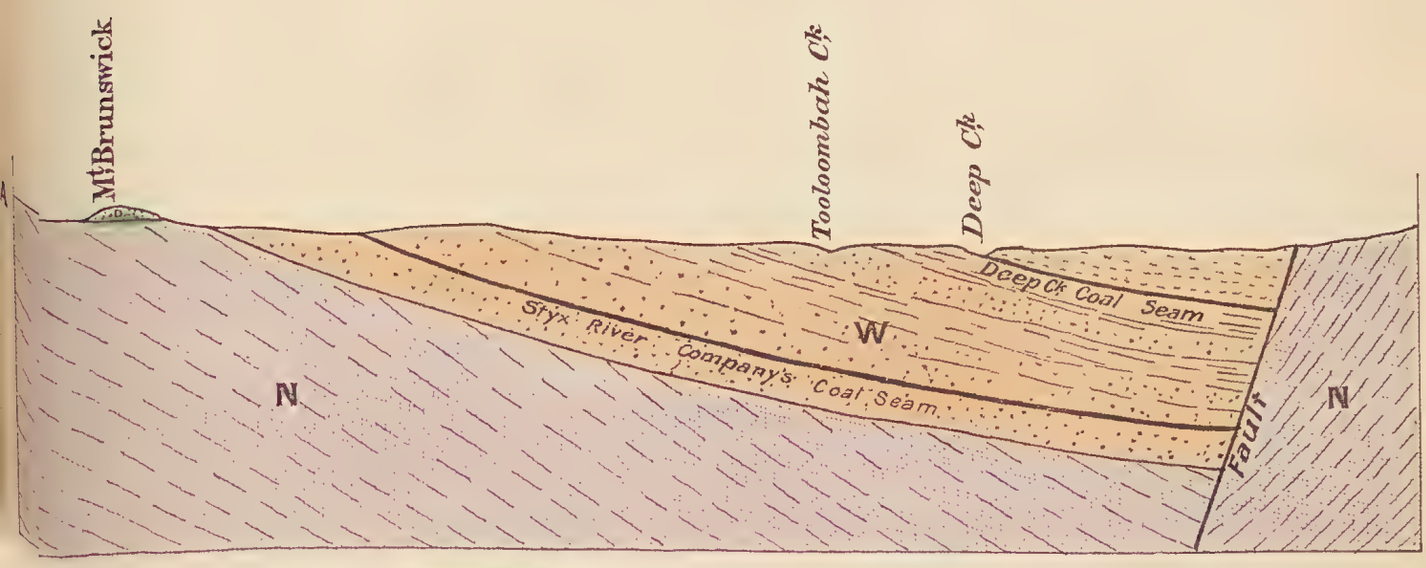


Fig. 1.



Desert Sandstone D Coal-Measures W Permo-Carboniferous N

Fig. 2. Section along line A. B.

VICTORIA

MUSEUM VICTORIA

85

1892.

QUEENSLAND.

GEOLOGICAL OBSERVATIONS IN BRITISH NEW GUINEA IN 1891.

(BY A. GIBB MAITLAND, F.G.S., ASSISTANT GEOLOGIST, GEOLOGICAL SURVEY OF QUEENSLAND.)

(WITH THREE MAPS AND THREE PLATES.)

Presented to both Houses of Parliament by Command.

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INTRODUCTION.

The geological observations recorded in the present Report are the results of an official visit to British New Guinea during the months of May to October, 1891.

The Report does not profess to accuracy in detail, for the reason that the time allowed at any one spot was too short for systematic work, but is rather intended as a preliminary to a more thorough exploration, which it is hoped some competent observer may undertake in the future.

During my visit I had opportunities of examining into the geology of a considerable portion of the Possession. The New Guinea Government yacht, the "Merrie England," was employed as a means of locomotion and as a base of operations. As many instructive sections were best seen along the coast, these were examined by means of native canoes or boats. When opportunity offered I made traverses for short distances inland. As, however, I accompanied a rapidly moving party, engaged upon administrative inspection, it is evident that the geological observations made could not be of a very detailed character.

Several cases of geological specimens presented by the Administrator, Sir William Macgregor, M.D., K.C.M.G., to the Museum of the Queensland Geological Survey, have been examined and reported on by various members of the staff. The specimens of themselves threw no light upon the structure of the country; but as most of them were collected from localities which I had no opportunity of visiting, their value as a means of unravelling the geology has been materially increased. By their aid the broad outlines of the geology of a large area of territory have been obtained.

Wherever any light is thrown upon the geology of those portions of the country with which it was impossible for me to make any personal acquaintance, I have quoted freely from the writings of other observers.

The following is a brief summary of my proceedings:—

In pursuance of instructions received from the Government, through Mr. R. L. Jack, Government Geologist of Queensland, I left Townsville for Cooktown in time to join the "Merrie England," which was expected to arrive from New Guinea during the second week of May. I reached Cooktown on the morning of May 8th. After a two days' voyage across the Gulf of Papua, Port Moresby, the seat of Government, was reached on the 23rd of May.

In company with the Administrator and his staff, I left the capital on the 27th of May by steamer for the east end of the Possession. From that date until my arrival in Samarai (Dinner Island), the residence of the Magistrate of the Eastern Division, I examined the geology of various portions of the coast, and some of the adjacent islands.

After remaining a few days at Samarai, the party proceeded by steamer through Goschen Straits, as far as Bartle Bay, remaining a short time at various places along the coast.

From Bartle Bay, I visited that portion of the D'Entrecasteaux Group in the vicinity of Dawson Straits, and from thence returned to Samarai on the 24th of June.

I was able to make a hasty traverse of the Louisiade Archipelago, and an examination of the quartz-reefing district of Tagula (Sudest Island), and the alluvial workings of Misima (Saint Aignan) Island, during the early part of July.

After spending a few days in visiting the islands and mainland adjacent to Samarai, I left for the village of Tauputa in Awaiama (Chad's Bay), where the services of forty natives to act as porters in an expedition, under the leadership of the Hon. M. H. Moreton, to the flanks of Mount Suckling, in Collingwood Bay, were secured. To this work three weeks were devoted.

In the early part of August I accompanied the Administrator across the country dividing Milne Bay from Pouro (Mullen's Harbour).

On returning to Port Moresby on the 13th of August, I devoted a few days to a traverse of the Laloki River, as far as the Astrolabe Range.

The

The first three weeks of September I spent in the Mekeo (or Saint Joseph) district, but the unsettled disposition of the natives, coupled with wet weather and attacks of fever (from which I was not free since leaving Mount Suckling) prevented much geological work being done.

I returned to Queensland in the early party of October, *viâ* Thursday Island, after visiting Mabaduan, the headquarters of the Magistrate of the Western Division of the Colony.

To give a transcript of the journal kept during my journey—including as it does reference to modes of locomotion and other vicissitudes of travel—would be out of place in a scientific report, and would increase it to dimensions out of proportion to its general utility. Any extraneous matter mentioned is merely such geographical and other information as is necessary for a right comprehension of the geology.

This Report is accompanied by three Maps. These have been compiled from the Admiralty Charts, from surveys conducted under the auspices of the New Guinea Government, and from surveys or itineraries of private travellers.

The scale of the Map No. 1 is upon ten miles to the inch; that of No. 2 upon the same scale as that of the Admiralty Chart; whilst that of the General Map is upon the scale of thirty-two miles to the inch.

On Map No. 2, embracing the Louisiade Archipelago, the general features of the submarine topography has been shown by means of contours, at 10, 20, 30 and 100 fathoms. No attempt has been made to distinguish between the different forms of coral reefs. The raised reefs are coloured cobalt blue, and the others are indicated by mere shading.

The mountain ranges have been indicated by hill shading, only in a general way, and have no pretentions to more than general accuracy. As little or no triangulation has been carried out, and the plane-table, even, has not been used to any extent, our present knowledge of the topography of the interior depends mainly upon traverses of the rudest kind.

The present maps are as near an approximation to the truth as is possible with the available data, and may serve as a basis of our knowledge of the topography, until the state of the country necessitates the execution of more than flying reconnaissances.

In the selection of names of localities the custom prevalent in the country of giving prominence to those names by which the different places are known by the native inhabitants has been adhered to on Maps 1 and 2. The English name has been placed in parentheses and in a much smaller type. Where it has not been possible to learn the Papuan name, the English one has been given, but in the same type as that which it would have had had the native name been known.

PREVIOUS OBSERVATIONS.

As far back as the year 1844, Mr. J. Beete Jukes, the Naturalist to H.M.S. "Fly," visited, in the course of his travels, a portion of New Guinea at the head of the Papuan Gulf, but in the account published in "The Voyage of the Fly," no mention is made of any geological facts bearing on the district.

The following passage by Mr. J. Macgillivray, summarising the results of the work of H.M.S. "Fly," probably explains the absence of geological data:—

"This country presented a great sameness of aspect; low muddy shores covered at first with mangroves, and further back with dense forests, were found to be intersected by numerous channels of fresh water, the mouths, there is reason to suppose, of one or more large rivers, of which the great extent of country is the delta. Great mudbanks, extending from ten to twenty miles out to sea, prevented approach except in boats."*

The geological pioneer of what is now British New Guinea was undoubtedly Mr. John Macgillivray, the Naturalist who accompanied H.M.S. "Rattlesnake" to New Guinea and the Louisiade Archipelago in the years 1846 to 1850. From his pen we have the first account of the geological features of part of the coast line and of some of the islands of the Louisiade Archipelago.

In the year 1885, Dr. Haacke, as Geologist and Zoologist to the Expedition fitted out by the Royal Geographical Society of Australasia, visited the Strickland River, an important tributary of the Fly. So far as I have been able to ascertain, there does not appear to have been any account of the geological features of the district published by Dr. Haacke.

The late Mr. C. S. Wilkinson, Government Geologist for New South Wales, examined the specimens collected by the party, and prepared a Report which was published under the auspices of the Royal Geographical Society.† From this Report the following quotations are made:—

"For a distance of fifty miles up the Strickland River to Douglas Bend, the country on both sides of the river is low and undulating, and the banks scarcely above flood level, except in places where they were formed of cliffs, twenty-five to forty feet high, of red and yellow ferruginous sandy clays. The samples collected from these cliffs show that the deposits are evidently of Tertiary or Pleistocene age, though no fossils were found in them."

From a spot called the Observatory Bend, seventy-five miles above the confluence of the Strickland with the Fly, where the "Bonito," the steam launch used by the expedition, got aground, a number of travelled boulders were obtained. Among the pebbles were "red and white marble, limestone, altered slate with quartz veins (Silurian), brown jasperoid rock, quartz, syenite, dense basalt, vesicular basalt, scoria, and pebbles, indurated calcareous shales containing beautiful casts of Ammonites and other fossils of Cretaceous age."‡ These fossils were submitted to Mr. R. Etheridge, junr., who recognised among them "four more or less recognisable species, or at any rate species which can be referred to one or other of the sections into which the old genus *Ammonites* is now broken up, and the facies of which is sufficiently clear for broad generalisation."‖

The following Ammonites, figured and described in the Paper from which the above quotation is made, were recognised by Mr. Etheridge:—

Stephanoceras, allied to *S. lamellosus.*
Stephanoceras, allied to *S. Blagdeni.*
Stephanoceras, allied to *S. calloviensis*;
and an Ammonite allied to *Ammonites lingulatus.*

Mr.

* J. Macgillivray. "Voyage of H.M.S. 'Rattlesnake.'" London, 1852, vol. i., page 179.
† Trans. and Proc. Roy. Geogr. Soc. Australasia; N.S. Wales. Vols. iii. and iv., pp. 203-206.
‡ Wilkinson, *loc. cit.*
‖ Etheridge. "Palæontology of New Guinea." Rec. Geol. Sur., N. S. Wales, vol. i., Pt. 3., p. 175.

Mr. Wilkinson states in his Report that above the Observatory Bend "high precipices along the river were formed of sandy calcareous strata, of a dark greenish colour, full of fossil shells of Cretaceous age; among those collected are *Gryphæa*, *Modiola*, *Aviculopecten*, *Protocardium*, *Cidaris*, *Inoceramus*, *&c.* From these strata the fossiliferous pebbles found in the shingle bed of the river at Observatory Bend were no doubt derived."*

In the same Paper mention is made of the discovery of a thick seam of lignite along the banks of the Strickland River. This is said to be of no commercial value.

At a date subsequent to 1883, Mr. William Denton, an American Geologist, met his death when exploring in New Guinea, but no account of his labours appears to have been made public. The knowledge of most of the other writers has been obtained from specimens submitted to them for examination.

From the pen of Mr. A. W. Clarke, F.G.S., of Charters Towers, some time Mineralogical Lecturer to the Queensland Government, in a Paper entitled "Petrographical Notes on some Specimens from Queensland and Adjacent Colonies," incorporated in the forthcoming work, "On the Geology and Palæontology of Queensland," by Messrs. Jack and Etheridge (now in the Press), we have a good description, accompanied by illustrations, of the Basalts of Goodenough Island and Mitre Rock, the Rhyolites of Nell Island, and the Obsidian from Fergusson Island.

The reports by the present members of the Queensland Geological Survey, bearing upon New Guinea, will be mentioned when treating of the districts to which they refer.

An excellent summary of what is at present known of the palæontology of New Guinea is given by Mr. R. Etheridge, junr., in Part iii., Vol. 1, of the Records of the Geological Survey of New South Wales, in 1890.

The attention of those interested in mining has been directed within the last few years to the country, from the reported discoveries of gold in the adjacent islands.

Until the rush from Australia to the islands of the Louisiade Group, in 1888, no great quantity of gold had been obtained in the country. From that time there have been reported to the Customs authorities at Cooktown nearly 10,000 oz.

Appendix A is a Bibliography of the Geology of New Guinea, comprising as complete a list of papers bearing on the subject as it is possible for me to obtain.

PHYSICAL GEOGRAPHY.

Without some mention of the more important orographical features of British New Guinea, this Report might be in some measure considered deficient.

A great deal of important and valuable geographical information is contained, buried among other matter, in some of the Despatches published by His Honor the Administrator. From these, and other sources, I have endeavoured to extract that which is of importance, in order to bring within as reasonable a compass as is consistent with lucidity what is known of the main physical features of the Possession. It will be seen in the sequel that really very little is known of the geography of the interior of the country. Much yet remains to be done in delineating its physical features, for an unusually large portion of country is blank on the existing maps.

To describe the coast line and adjacent islands would be an almost endless and useless task. This has already been done by the Hydrographical Department of Great Britain, in Volume ii. of the Pacific Islands Sailing Directions (Western Division).

The geographical portion of this Report is in every respect a compilation, and does not contain any observations made by myself.

MOUNTAINS.

Victor Emmanuel Range.

As seen by the Administrator's party from a spot estimated to be five hundred and ninety miles from the mouth of the Fly River, the Victor Emmanuel Range, believed to be in German territory, near the north-west corner of the Possession, appeared to consist of two distinct chains. The range is thus described:—

"The nearer [chain] was about thirty-five to forty miles from us in a straight line, runs in a general north-easterly direction, is covered by forest to the top, and rises to a height of five to six thousand feet above sea level. It is a rugged mountain, but presented a long sloping face towards us, which would be easy of ascent. The more distant chain was about forty-five miles away in a straight line, and at this distance, with the light then on it, looked of a deep blue even surface, less rugged than the nearer range. It rises to probably ten to twelve thousand feet, and runs nearly east and west."†

The

* With reference to the presence of strata of Mesozoic age in British New Guinea, the Writer has had the opportunity, since this Report was in type, of consulting a general Geological Map of Oceania, No. 15 of Berghaus' Physikalischer Atlas, published by Justus Perthes, at Gotha, in 1888.

On this Map, there is shown at the head of the Papuan Gulf waters, a large area of Mesozoic Rocks, in the Philp River, a tributary of the Douglas of Mr. Theo. Bevan's map. In the absence of explanatory notes, I have been unable to learn the exact grounds upon which the presence of these rocks has been ascertained. With the exception of Captain Blackwood's party (of which Mr. J. Beete Jukes, the Geologist, was a member), nearly half a century ago, and that of Mr. Bevan, in 1887—until the visit of the Administrator, in March of this year, I believe no one had penetrated for any distance from the coast.

A suite of specimens, collected during the Administrator's recent visit to this district, has been placed in my hands for examination, and notes upon them will be embodied in the Report on the Petrology of British New Guinea, now in course of preparation. This collection contains, amongst others, specimens of white sonorous limestones from the Tumu Hills. These limestones contain unexamined molluscan shells, and in hand specimens bear a striking resemblance to those forming the upraised coral-reef masses, which are such a conspicuous feature in the country to the east.

Mr. Licensed Surveyor Hemmy, who accompanied Mr. Bevan in his explorations at the head of the Papuan Gulf, mentions in his Report, quoted on a later page, some limestone hills from above the village of Tumu. It is quite possible that the fossiliferous limestones (which bear some resemblance to chalk) collected by the Administrator's party, and labelled Tumu Hills, may be from the same locality.

As the Geological Map of Oceania bears the date 1888, and Mr. Bevan's Expedition was undertaken in the preceding year, it is very likely that the explanation of the Mesozoic area of the Philp River is the indirect result of his visit.

On the other hand, Mesozoic Rocks are known to be present somewhere in the country drained by the upper reaches of the Fly River, and it is within the bounds of possibility that these rocks extend eastwards to the waters flowing into the head of the Papuan Gulf.

Until the fossils collected by the Administrator's party have been examined, the whole question of the age of these Tumu limestones must be left in abeyance.

† Despatch 1, 1890, par. 27.

The same party got a further glimpse, at six hundred and two miles from the mouth of the Fly, of the Victor Emmanuel Range, and of a much lower range thought to be in British territory. The Administrator gives a further description of the range and "foothills" in the following terms:—

"About two miles above our six hundred mile camp, we had a very fine view of the mountain ranges in sight, showing very plainly their connection. . . . . The more distant chain, the Victor Emmanuel Range of D'Albertis, appeared to be about forty-five miles from us at its most northern end, and from thirty to thirty-five miles at its south-west termination. It is precipitous in the extreme at the high north-east peaks, presenting gigantic cliffs of bare rock, with very little vegetation in the ravines or crevices between them. There was no forest near the summits. From this side it looked hopelessly inaccessible. It appeared from this point to reach an altitude of probably not less than twelve thousand feet on the highest point. The south-west portion of this great range was well forested, but of not more than half the height of the northern part, but one mountain of the south-west portion was excessively rugged and precipitous. This range appears to be exclusively in German territory. Right between us and the Victor Emmanuel Range, about ten miles distant in a straight line, lay a mountain range, perhaps twenty to twenty-five miles in length. It is from fifteen hundred to two thousand feet high, and covered by forest to the summit. To ascend this, no physical difficulty has to be overcome. This range, which is a narrow one, we believe to be in British New Guinea, and I have named it Mount Donaldson, in honour of the Treasurer of Queensland.

"In between the north-east end of Mount Donaldson and the Victor Emanuel Range there is fitted the bold western end of a very steep and rugged mountain range, which may be fifty miles long, and reaches to a height of probably five to six thousand feet above sea level. Some portion of the range, as seen from this point, would appear to be in British territory, and was within ten miles of us in a straight line. But it seemed to me clear that the highest part of this range which came under view was in Kaiser Wilhelm's Land. I have, therefore, as a name to it is necessary for convenience of reference, conferred on it the great historical one of Blücher, a German name that is a household word to British ears. Mount Blücher is covered by forest over the summit, but is so steep on the southern aspect as to be subject to immense land-slips. The outline of a recent one was as white as a chalk cliff, about a mile long and several hundred yards broad. There was quite visible the form and dimensions of another still larger, which, judging from the growth of the young vegetation on it, had probably taken place three or four years ago. There would be much difficulty in scaling this mountain from the British side, but it is easy of access from the east end, which was, however, probably two score miles from us.

"A large branch of this mountain proceeds from about its central portion in a north-easterly direction, apparently rising in height as it proceeds; but whether it joins the great Victor Emanuel Range further north could not be seen.

"The general direction of Mount Blücher is from south-east to north-west. From its length it is difficult to find a spot from which the whole range is visible."*

The Bismarck Range.

From the Victor Emanuel Range to Kovio practically nothing is known of the mountains of the interior.

Mr. Theodore Bevan merely mentions in the country at the head of the Papuan Gulf a high range of mountains, the so-called Bismarck Range, one peak of which was estimated by the Surveyor accompanying Mr. Bevan to attain an elevation of thirteen thousand two hundred feet. "In these mountains rise the two main rivers—viz., the Aird River system and the Queen's Jubilee River, which disembogue into the Pupuan Gulf over one hundred miles of littoral, between east longitude 144° and 145° 40′, through a multitudinous delta."†

Kovio Range.

To Mr. George Belford, a Samoan half-caste, the Leader of the Royal Geographical Society of Australasia's Expedition to the summit of Kovio (Mount Yule) is due the credit of giving what information is extant with reference to the geography of the Kovio Range. A *précis* of the results obtained by the party are given by Sir William Macgregor in a Despatch referring to the Expedition. These paragraphs may be appropriately inserted here:—

"The principal points of interest elicited are, that what seems from the coast to be the highest point of a great mountain mass, and is known as the top of Kovio, or Mount Yule, is a solitary isolated great pillar or peak, and not an integral part of the mass of the range. The range seems to be volcanic in its formation. The nature of the country between Mount Drew and the Tully Peaks seems to be schistose, with traces of gold. The Kovio Range is wooded to the top, and is not of sufficient height to present any of the grassy treeless summits found above eleven thousand feet and upwards on Mounts Victoria, Albert Victor, Scratchley, and Knutsford on the Owen Stanley Range. Native paths lead to the top of the Kovio Range, and there are many native villages on the ridges and low country all around it; in fact that part of the interior seems to be tolerably thickly populated.

"A sheet of water, several square miles in area, was seen from the top of the range, but its position cannot be located at present. It is probably on one of the rivers opening into the sea near Motu Motu. They crossed nothing deserving the name of 'river' west of the large stream mentioned in the first Report as separating Mount Drew from the Mekeo Range. The weather was very wet; animal life was far from abundant. They remained only an hour or two on the top of Kovio, and consequently the geographical data are not very full.

"It will be necessary to follow up the task so far accomplished. The large river between Mount Drew and the Mekeo Range has to be traced to the sea; the geography of the country near the Mekeo Range requires much further examination; relations have to be opened up with the natives; the upper stretches of the river mentioned above require to be followed up, and the great range proceeding north-east from Kovio towards the German boundary is well worth attention. Before attempting this, it will be advisable to obtain some acquaintance with the language of the tribes at and immediately inland of Motu Motu."

Mr.

* Despatch 1, 1890, par. 30.

† Bevan, Theo., F.R.G.S. "British New Guinea, from the Protectorate to the Sovereignty." London, 1890, p. 304.

Mr. Belford thus describes the large lake:—

". . . . Lying a little south of west of Mount Yule, and about an equal distance between the line of the main range and the coast. From our point of view the circumference was somewhat like a figure of eight, the larger portion being about eight miles in diameter. The smaller part, which trended in a north-westerly direction, was from three to four miles across. The land surrounding this sheet of water for a considerable distance is flat and grass-covered, dotted about with clumps of trees. Its shores, excepting at the south-western corner, are free from timber, and no islands showed themselves. The country further west appeared to be swampy, as several spaces of water were seen amidst the timber. Between the lake and the coast the natives were burning off grass, as the hunting season was not yet over. Although the coast range appears to divide the lake from the coast country and people, its western shore cannot be much more than twelve miles from the coast, or difficult of access by the Coombs River, which, from its relative position on the chart, must pass at no great distance to the south of the lake. I should have much liked to have attempted a nearer examination of this fine sheet of unknown water, but rations being short, and my instructions decided as to the date of return, I did not care to lengthen the journey."

As viewed from the summit of Kovio, the Leader remarks that the "Mount Yule Range shows five distinct peaks, and is entirely separated from other easterly chains by the valley of the river which, flowing from the direction of the western slopes of Mount Owen Stanley, circles round the southern foot of Mount Yule, and to all appearance mingles eventually with Coombs River. The western portion of Mount Yule appeared to diminish in height until it subsided on the plains north of the lake. It was impossible, owing to the thick weather, to get a good view of the inland country due north of Mount Yule; but the Mekeo Range, between the Mount Owen Stanley Range and the detached group of Mount Yule, was seen in well-marked outlines. No traces of native habitations were noted on Mount Yule Range, but some recent land-slips—one of considerable size—had taken place."

Owen Stanley Range.

The Owen Stanley Range is not that continuous ridge of mountains represented on the charts, but a wide mass of ranges furrowed with deep gorges and "bristling with peaks and pinnacle-like rocks, and contains hundreds of inaccessible crags and precipices."

In 1889, the Adminstrator of British New Guinea ascended the Vanapa River, navigable for about thirty-five miles from its mouth, and from thence succeeded in reaching the summit of the Mount Owen Stanley Range. Mount Knutsford, about 11,000 feet in height, is said to end "in two masses of rock, each about one hundred feet high, that stand about a quarter of a mile apart."

The highest point of the Owen Stanley Range was named by the Administrator Mount Victoria (13,121 feet). "The crest of Mount Victoria runs from south-east to north west, and may be described as composed of six different peaks. Mount Victoria is far from being the isolated block it has been customary to represent it. It is simply the eastern end of the Owen Stanley Range, which runs without any break, as one continuous whole, from the south-east end of Mount Victoria until the range meets Mount Griffith and Mount Scratchley. The length of this part of the range (for it continues further west into Mount Thynne and Mount Lilley) is about twenty to twenty-five miles. The lowest part of the Owen Stanley Range, from the east end of Mount Victoria to the junction mentioned as Dickson's Pass . . . . . is 10,884 feet in height.

"The Owen Stanley Range ends at the east in Mount Victoria, beyond which there are a number of low-rounded hills, separating it from the range in which Mount Obree is situated."

The whole of the southern face of the Mount Owen Stanley Range is drained by the tributaries of the Vanapa River.

North of the range, between it and the coast, the exploring party noted a great extent of comparatively flat country.*

The following is a list of the more important altitudes obtained by the Administrator's party:—

Mount Victoria		13,121
„ Albert Edward		12,500
„ Scratchley		12,250
„ Winter Height		11,882
„ Knutsford		11,157
„ Douglas		11,796
„ Dickson Pass		10,864
„ Service	between	10,000
„ McIlwraith	and	11,000
„ Morehead		
„ Griffith		11,000
„ Musgrave		9,150
„ Gillies		8,000
„ Parkes		8,000
„ Belford		3,500
„ Kowald		2,620
„ Gleeson		1,292

Astrolabe Range.

This range, which forms a table-land at the foot of the main range or backbone of the country, appears to have been first described by Macgillivray. He says:—"Mount Astrolabe† differs in character from any other of the New Guinea mountains seen by us, indicating a different geological formation. The summit extends thirteen miles, running parallel with the coast line, and distant from it about eight miles. Viewed from the south westward, the outline is regular, exhibiting a series of nearly flat tops with slight interruptions, but from the southward it appears as a succession of terraces or projecting cliffs, precipitous in front, near the summit, with a long steep slope below, probably the *débris*, while the flat top slopes backward with a very gentle declivity."‡ From

* The above description is extracted from the Paper, "Journey to the Summit of the Owen Stanley Range," by Sir Wm. Macgregor. Proc. Royal Geogr. Soc. London, vol. xii., No. 4, 1890.

† I presume the range is meant. A.G.M.

‡ Macgillivray, J. "Voyage of H.M.S. 'Rattlesnake.'" Vol. ii., p. 60, London, 1852.

From Port Moresby I visited the Astrolabe Range. The country is fully described under the heading "Geology." The same district was described by the Administrator in 1890. From the top of the range at Warirata Mountain the country between it and the sea was seen to be "covered by the light-green sickly-looking Eucalyptus, streaked here and there by a dark meandering line indicating the course of a small stream, and the presence of ordinary forest trees of darker richer foliage. At the top of the mountain this changes to a mixture of the two forms of vegetation, and the Eucalyptus grows there side by side with the Pine and the Cycas. The range is of a conglomerate of a somewhat peculiar type; it consists of angular small stones in a granular basis deposited in horizontal layers, which are plainly marked, both at a distance of several miles in the mountain mass as well as close at hand in the individual boulder and precipice. Looking northward from the top of Warirata, the whole country is forest-clad as far as the top of the great central dividing range. It is extremely rough in many places, consisting of steep and rugged conglomerate rocks, forming abrupt ridges separated by narrow gorges and valleys, in which there is, however, often rich soil."*

Mount Obree (Wonorogoro).

On physical grounds Mount Obree—using the term to embrace the whole mass of the mountain—does not appear to be part of the Owen Stanley Range, as has been generally supposed.

Little is known of this range. Mr. W. R. Cuthbertson conducted an Expedition up the Kemp Welch, and attained an altitude of 8,000 feet, which height this observer gives to the summit, and not 10,246 feet as shown by the charts. Owing to the unfavourable nature of the weather during Mr. Cuthbertson's journey, it is quite possible that he may have mistaken an important elevation for the summit of Mount Obree.

Up to a height of 5,065 feet, Mr. Cuthbertson states that the sides of the mountain slope at an angle of about 45°; at 7,000 feet the sides became very precipitous, while the summits were perpendicular cliffs.†

Mount Suckling.

The only other portions of the main range visited are the northern flanks of Mount Suckling, from Collingwood Bay, by a party of which I was a member. The greatest altitude attained by us was 7,718 feet above the sea level. Our further progress was prevented by an unforeseen precipice, appropriately named, by the Leader, Disappointment Rock. This precipice ended in a moss-covered cliff, one hundred feet in height in front, and a bare wall three hundred feet high on the left, while to the right our route was barred by a rugged slope overgrown with timber.

We were enabled to ascertain that the Mount Suckling mass culminated in two conspicuous summits, the elevation of which, owing to the impossibility of measuring a base line, we could not compute. The Admiralty Chart gives 11,226 feet as being the altitude of Mount Suckling, but it is doubtful whether the peak to which the altitude is given by the Hydrographical Surveyors is one of those seen by us from our coign of vantage at Disappointment Rock.

The geographical information obtained by us was much more meagre than could have been wished. We were unable to see much of the main range at this point. We however ascertained that "the spurs of the main range approach to within some six or eight miles of the sea in a straight line, leaving no place for the so called Hornby Range of the charts, which clearly does not exist."‡

Under the head of Detailed Description will be found such geographical results of the Expedition as have any bearing on geology.

RIVERS.

The Fly.

The most important river in British New Guinea is undoubtedly the Fly. For a description of this river and its affluents we are indebted to D'Albertis, Sir William Macgregor, and Captain Everill.

At the mouth of the Fly Delta lies the large Island of Kiwai, described as "about thirty six miles long, and about two and a-half broad. . . . . It is perfectly flat; probably no part of it is two yards above high water mark; considerable areas are something below the mark of high spring tides."§

During the ascent of the Fly, in 1889-1890, by the Administrator, near the Coal Depôt, in lat. 7 deg. 53 min. 16 sec. south, long. 141 deg. 47 min. east, opportunity was taken "to as accurately as possible estimate the quantity of water coming down the Fly River at a spot just beyond tidal influence, and at a time when the stream was probably about an average volume. The average depth straight across from our camp to the opposite bank was found to be thirty-nine feet; the average current at a rate of 3·25 miles an hour, and the width of the river six hundred yards. Our estimate of the quantity of water coming down in twenty-four hours was, in round numbers, 180,000,000,000 gallons. To put it in a simpler form, and to make the significance of these figures more comprehensible, it may be stated that the Fly River sends down fresh water enough to supply twice the present population of the globe with sixty gallons a day per head."‖

The first and perhaps the most important tributary of the Fly is that which was examined in 1885 by Captain Everill, in the s.s. "Bonito," and named by him the Strickland River, out of compliment to Sir E. Strickland, President of the Royal Geographical Society of Australasia. The Strickland joins the Fly in lat. 7 deg. 34 min. south, long. 141 deg. 21 min. east.

At Everill Junction, on the return journey, the Administrator's party made a comparative estimate of the quantity of water being carried seawards by the Fly and the Strickland. With reference to this it is stated:—

"The Strickland was rising fast, judging from the fact that the surface of the river was half covered with drift wood. The Fly was also rising, but its greatest flood had been left behind us, and had not

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* Despatch 172, 1892, par. 4.

† Cuthbertson, W. R. "Explorations in the Highlands of South-Eastern British New Guinea." Proc. Royal Geogr. Soc., Austr, vol. v., Pt. 2., 1887.

‡ Despatch 58, par. 2, 1891.

§ Despatch 113, 1889, par. 2.

‖ Despatch 1, 1890, par. 1.

not yet reached the junction. Measurement of the two rivers under these conditions is not therefore a fair test of their comparative value. We found them to contrast as follows:—

	Depth.	Width.	Current.
Strickland...	10·8 yds.	420 yds.	3·3 m. per hour.
Fly...	14 „	302 „	1·5 „

"This gives the quantity of gallons of water coming down in twenty-four hours as:—

"Strickland	106,000,000,000.
"Fly	45,000,000,000.

"The total thus derived is still much less than that found in the Fly at our Coal Depôt. A great many creeks and lagoons enter the river between these two points, and it is possible there may be considerable tributaries discharging through the lagoons."*

The Strickland, throughout the whole of its known course, flows through nothing but low undulating country.

At about three hundred and seventy miles from the mouth of the Fly the first real grass patches were met with. "The banks began to be firmer, higher, and better defined, and the country generally became much less swampy, but was still low and wet."†

The next important branch of the Fly is the Alice. This disembogues into the Fly at D'Albertis Junction (Snake Point of D'Albertis) in lat. 6 deg. 11 min. south and "about eight miles east of the boundary between British and Dutch New Guinea. According to Mr. Cameron's traverse, which has been carried out with great care, and has at various points been tested and compared with astronomical observations it is four hundred and sixty miles from the mouth of the river. Both the Fly and the Alice were very low when we arrived."

In size and volume the Fly and Alice Rivers compare roughly thus:—

	Fly.		Alice.
Width	207 yds.	...	152 yds.
Depth, average	15 feet	...	12 feet
Current, per hour ...	1½ miles	...	2 miles
Gallons in 24 hours ...	11,000,000,000	...	8,500,000,000

At about five hundred and ten miles from the mouth of the Fly, the low flat country ceased, and the river wended its way among low rounded and forest-covered hills a few hundred feet in height.

The next important tributary was that to which the name of the Palmer was given. At the junction of the two rivers they were so nearly equal in size that some difficulty was experienced in deciding which should be considered the Fly and which the tributary. "One river has, from the junction, a south-south-west, the other an east-north-east course. A rough calculation was made of the volume of water coming down each, with the following results:—

	Fly.		Palmer.
Average depth	2⅔ fathoms	...	3 fathoms
Width	130 yds.	...	120 yds.
Current per hour	3 miles	...	2½ miles
Gallons in 24 hours	14,760,000,000	...	12,770,000,000.

"At the time this measurement was made both were beginning to rise, but the flood coming down the east-north-east branch was passed by us, and had not arrived at the lower reaches of the river, while that of the other more rapid-running stream was already there. It is thus quite possible that under conditions similar to each river the decision as to volume might be reversed. On the somewhat unsatisfactory data thus at command the east-north-east river was considered to be the branch. . . . The two rivers differ greatly in character. . . . The Fly maintains a broad channel, the southern two hundred yards of which, at and for half a mile above Palmer Junction, is composed of shingle, uncovered by water save at very high flood time. The Palmer, on the other hand, is narrow, deep, and much less sluggish; far better fitted for navigation purposes than the Fly."‡

One important feature to forcibly strike the observer is the course taken by the Fly River. Practically speaking, to about lat. 7 degrees 30 minutes south, its course is due south, then it gradually turns eastward and enters the sea at the head of the Papuan Gulf.

The rocky islands of Torres Straits and Cape York probably are the diverters of the Fly.

Mabaduan Hill, geologically identical with the island of Duan (Cornwallis), strikes the observer forcibly as being an island which has been entirely surrounded by alluvial *débris*. Duan itself is separated from the coast of New Guinea by an unusually shallow channel.

The Morehead.

This river is the only one between the Wassi Kussa and the Dutch frontier. Its mouth, at the head of Heath Bay, is said to be in lat. 9 deg. 15 mins. south, and long. 141 deg. 30 mins. east.

In the early part of 1890 this river was followed up as far as lat. 8 deg. 33 min. south, and long. 141 deg. 38 min. east.

The mouth of the Morehead is from one hundred and fifty to two hundred yards in width and and four to five fathoms in depth. The water is quite fresh at the mouth at ordinary tides, and is said to be fit for use at low water out in Heath Bay.

In the last thirty miles of its course the character of the country through which it flows appears from the following description by an eye-witness to be very much the same:—"All is perfectly flat and covered by forest, the prevalent trees being mangrove in some form; the banks are, at most places, sufficiently firm to enable one to land on them, but the country is too low and wet for human habitation, of which there is no trace beyond about half a dozen cocoanut trees growing singly over a distance of about a score of miles.§

"The bed of the river at forty or fifty miles up is often ill defined, shading off into swamps, so that it is difficult to say where the river ends. There was often only fifty or sixty yards of water in the middle free from grass or reeds. The open spaces became larger higher up, so that at fifty or sixty miles there are sometimes grass plateaux of several hundreds of acres in area.‖

"At

* Despatch 1, 1890, par. 8. † Despatch 1, 1890, par. 14. ‡ Despatch 1, 1890, par. 23.
§ Despatch 18, 1890, par. 11. ‖ *Loc. cit.*, par. 12.

"At about ninety-five miles up the river there is on the left bank a small hill some fifty or sixty feet high, covered by large timber. The country in that district consists of flat plateaux of much the same kind as those described as existing below, but all of limited extent, and sloping away into swampy or wet ground all round. . . . At about one hundred miles up, the river receives its first branch—which is about sixty yards broad—on the right bank, from the north-west; but further progress was impeded at about one hundred and twenty miles from the mouth of the river, by some large trees that have fallen across stream."* At this point the river was thirty yards broad, and had a depth of three fathoms. The remark is made that the last fifty or sixty miles of the river, from the sluggishness of the current, resembles a large lake.

The Mai Kussa and the Wassi Kussa.

"For all present practical purposes the description of these rivers by Mr. Strode Hall, carried out by the direction of the Special Commissioner, the Hon. John Douglas, C.M.G., is sufficiently accurate. It may be observed, however, that his distances, though less than half those of Captain Strachan, appear to be over estimated. The names Mr. Hall has given to the rivers and creeks are those known to be used by the natives, and are quite different from the appellations given by Captain Strachan, who visited this part of the country in 1884 and 1885. The names given by Mr. Hall in the Sketch Map accompanying his Report . . . . have been adopted . . . . as being those best suited for public use; but the name 'Strachan Island,' as denoting the area enclosed by the sea on the south, and by the inlets Mai Kussa and Wassi Kussa on the east and west sides respectively, is retained in commemoration of Captain Strachan's explorations, which seem to have been attended with much hardship and much danger."

"The Mai Kussa is, at the mouth, about a mile wide; about three-fourths of a mile at the place where, five miles up, it gives off the first branch, the Yarro Kussa; and at about twenty-eight miles, where it meets the Wassi Kussa, it is about five hundred yards. From the junction of the two arms a branch runs nearly north. At first it is about three hundred yards broad, and after giving off some branches has a breadth of twenty-five to thirty yards at forty-three miles from the sea. At thirty-six to forty miles from the coast the water in this branch is sufficiently fresh to be fit for use, but the water of the Mai Kussa and Wassi Kussa is simply sea water. The depths of these inlets vary from five to thirteen fathoms, but at our highest point was only about two fathoms. In the Mai Kussa, at about sixteen miles from the mouth, there is a rock in the river which will be nearly if not quite dry at low spring tides. There are probably other rocks in these channels, as there are many powerful eddies. . . . .

". . . . The whole country is covered by forest of different kinds of trees. The various species of mangrove predominate near the coast; as one proceeds further inland clumps of other trees are met with in the mangrove plain. At many places, after getting about five or ten miles from the coast, there are ridges rising thirty or forty feet above the river, covered by grass and different species of Eucalyptus; the grass is wiry, generally, and contains many plants of Nepenthes and Sundew, an indication of poor land. The soil on these higher parts is argillaceous, raw, and sour, nowhere suited for agricultural purposes."†

The Bamu.

The Bamu River enters the sea in what may be called the delta of the Fly River by three mouths, known respectively by the names of the Diribi (or Duro), the Bina, and the Bebea River.

The mouth of the Diribi branch of the Bamu is "about 1,000 yards broad and about two and a-half fathoms deep. The left bank, beginning from the sea, is about a yard above high water mark, and is covered by Pandanus and forest trees, overrun by creepers and with occasional patches of grass, and a dry ground species of mangrove. The right bank is low and covered by dense salt water mangrove."‡

Just above the junction of the Bamu and the Bebea, "the river is generally from two-thirds of a mile to nearly a mile broad, and varies in depth from one and a-half to as much as five fathoms, running down, when the tide is falling, at the rate of three and four knots."

To the junction of the Aworra, an important tributary coming in from the north, the country retains pretty much the same general character—densely wooded low-lying country. "The Aworra is rather a sluggish stream, from about 100 to 120 yards broad, and from four to five fathoms deep."§

Nothing further is known with reference to this river.

The Aird River System, and Queen's Jubilee River.

East of the Bamu River the next important rivers met with go by the respective names of the Aird River System and the Queen's Jubilee River. "These disembogue into the Papuan Gulf, over one hundred miles of littoral, between east long. 144 deg., and 145 deg. 40 min. through a multitudinous delta." Portions of these have been visited by the Rev. Mr. Chalmers, and by Captain Blackwood, of H.M.S. "Fly," but for a geographical description of these rivers we are indebted to Mr. Theo. Bevan, F.R.G.S., and Mr. Licensed Surveyor Hemmy, who was placed at the disposal of Mr. Bevan by the Queensland Government.

Port Bevan, one of the entrances to the Aird River, says Mr. H. T. Hemmy, "is a large wide inlet of about three to four miles in width, having a deep channel passing between sandbanks, dry at low water all the way up to the mouth of the Douglas."|| Of the Aird Hills, thirty miles up the river from Cape Blackwood, the same observer states that, rising abruptly from the surrounding country, "they have a channel of water all round them. The highest peak is about 1,300 feet high; they are covered with dense scrub; the soil is a rich black loam. Both at and after passing Aird Hills the water of the river was quite *fresh*. There is a good deep channel up the river, but there are numerous mudbanks that make the navigation of it difficult to a stranger, The river widens out as soon as the hills are passed, and there are a great number of small islands in it; it also bears to the west for about six miles, where it diverges. One channel runs south, called by Mr. Bevan the Newberry River; it is the most direct outlet." An important tributary of the Douglas is the Philp River, coming in from the north. Of this, ascended by Mr. Hemmy, he says—"It is a deep, narrow river running between high peaked hills, in some places the hills coming down perpendicular to the river." Of

* Despatch 18, 1890, par. 13.

† Despatch 18, 1890, pars. 3 and 4.

‡ Despatch 31, 1891, par. 12.

§ *Loc. cit.*, par. 13.

|| Report on the rivers and country traversed on my trip with Mr. Theodore Bevan's Exploring Expedition in New Guinea, during November and December, 1887. As Appendix A to "British New Guinea, from the Protectorate to the Sovereignty, 1884, 1888." Theo. Bevan, F.R.G.S., London, 1890, pp. 286, *et seq.*

Of the rivers emptying into the head of the Papuan Gulf, the Queen's Jubilee River is reputed to be the most remarkable. From what is at present known of it, there appear to be two entrances—one, the Queen's Jubilee River proper, and another going by the name of the Aeivei River, forming a delta, which, Mr. Bevan writes,* "is fan-shaped or else likened to an irregular triangle, with Woodhouse Junction for its apex, and the thirty miles of littoral—viz., from Bald Head to the Aeivei estuary as its base line—giving a total superficial area of nearly 1,000 square miles."

The same Writer remarks in another portion of his report that—"A great portion of the delta bordering upon the sea is composed of a labyrinth of creeks filled with salt water, except where they communicate directly with the main trunk channels. What are known as the Sunderbunds of the Bay of Bengal find a counterpart in the almost impenetrable matted jungles and dreary swamps bordering upon Deception Bay."

Mr. Bevan again says of the Queen's Jubilee River—"Though from Bald Head, the highest point yet reached, is not more than fifty miles in a right line, the actual distance to be traversed *en route* is nearly double that length. One hundred miles by river courses inland, almost under the shadow of Mount Joseph, in south latitude 7 degrees 15 minutes—it is a greater river than the Thames at London Bridge, giving soundings in places of ten fathoms (sixty feet), 'no bottom.' The velocity of the current, which varies, according to the season of the year, from four to ten knots, has scoured out a channel down to the bed-rock, and the bottom affords no holding ground or anchorage at that distance.

"From its source among tropical alpine ranges it winds round the base of mountains till they dwindle down to foot-hills, and at last emerges on the extensive alluvial plain ten miles north of the head of the delta."

The Vanapa.

This description of the Vanapa is culled from a Paper describing the Administrator's ascent of the Owen Stanley Range, read before the Royal Geographical Society of London† :—

The Vanapa River opens into the inlet known as Galley Reach. The entrance to the river lies in a bend of the inlet where the coast is covered by mangrove swamps, and escapes observation unless expressly searched for. This doubtless explains the omission of this river on many of the charts. The Vanapa is navigable for boats for a distance of thirty-five miles from its mouth.

"The top of Mount Knutsford is the best point from which to note the rise and course of the River Vanapa. Nothing can be more clear than that it drains the whole of the south side of the entire Owen Stanley Range from Mount Victory to Mount Lilley. Indeed, besides that draining it carries almost nothing else to the ocean, as all the water it receives after reaching the north side of Mount Kowald is insignificant. At the north-west end of Mount Musgrave it divides into two great branches; one runs west, and drains the eastern slopes of Mount Cameron, the east and south sides of Mount Lilley, and the south sides of Mount Thynne and Mount Griffith; this branch cannot be much less than the eastern branch. The latter lies at first between Mount Knutsford and Mount Musgrave, and then for a short distance separates Mount Knutsford from Mount McIlwraith, until a projecting spur of Mount Victoria divides them. This branch then splits up into five distinct streams. The first one lies between Mount McIlwraith and Mount Morehead; the second between the latter and Mount Victoria; the third between Mount Victoria and the southern aspect of Mount Douglas; the fourth between Mount Douglas and Winter Height; and the fifth, the principal branch and real head of the Vanapa, flows between Mount Griffith and Mount Knutsford on the west, and that part of the main ridge of the Owen Stanley Range called Winter Height on the east."

No other river receives any part of the drainage of the southern aspect of the Owen Stanley Range.

LIST OF GEOLOGICAL FORMATIONS, WITH GENERAL DESCRIPTION OF THE SAME.

The Geological Formations so far known to occur in British New Guinea are as follows:—

(ϒ) *Recent Superficial Deposits.*—Wide plains along the rivers, coastal flats, &c.
(c) *Coral Reefs, Coral Islands, Upraised Reefs, and Associated Deposits.*
(A) *Kevori Grits.*—Grits, sandstones, and conglomerates—Post Tertiary.
(K) *Port Moresby Beds.*—Greenish sandy shales, limestones, calcareo-siliceous beds of Port Moresby—Tertiary (?).
(M) *Boioro Limestones.*—Greyish limestones, &c., of Boioro and the coast. Undetermined age.
(S) *Metamorphic Rocks.*—Schists, slates, gneiss, &c. Undetermined age.
Igneous Rocks.—
(B) Basalt and all other Volcanic Rocks, Ashes, &c.
(D) Diorite, and Granite Dykes.
Plutonic Rocks.—
(G) Granite, Mica-Traps, &c.

Recent Superficial Deposits. (ϒ)

The Recent Superficial Deposits of British New Guinea occupy an enormous area. To depict, with even an approach to accuracy, the territory which these deposits occupy is, in the present imperfect state of our knowledge of New Guinea geology, well nigh impossible. An attempt has been made to show portions of the known areas by taking advantage of the descriptions given by travellers who have visited the country. To distinguish by colour the various superficial deposits—viz., beach sandrock, coral sands, deposits of pisolitic iron, alluvial flats, and fragments of raised beaches—has been found impossible.

Coral Reefs, &c. (c)

The coral formations of British New Guinea present features of unusual interest.

No opportunity occurred of examining any of the existing coral reefs in the Possession. Most of them have been described by the Hydrographical Surveyors, and details will be found embodied in Volume II. of the 1891 edition of the Pacific Islands Sailing Directions (Western Division).

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* A few further Remarks on the Physical Geography of the Aird River system and Queen's Jubilee River, and their confluence with the Papuan Gulf. As Appendix E to Theo. Bevan's New Guinea, etc.

† Proc. Royal Geogr. Soc., London, vol. xii, No. 4, 1890, pp. 139, *et seq.*

The upraised reef masses and the associated deposits took up the greater portion of the time I was enabled to devote to this subject. These occupy a considerable portion of the north-east coast, the Louisiades, and some of the adjacent islands. Examples came under my observation in the following localities:—Einauro (Cette Island), Ware (Teste Island), Bell Rock, Pannietta Island, Kimuta (Renard Island), Misima, (St. Aignan), at various localities along the north-east coast from Awaiama Bay to Phillip's Harbour, and possibly in Hall Sound. All gradations from reefs only a few feet above the water, up to 2,000 feet above the level of the sea, can be seen throughout the area in question.

The rocks of which these upraised reef masses are composed present pretty much the same lithological characters throughout—viz., very hard and sonorous compact limestones of a whitish colour. Some varieties are of a distinct yellow or reddish-brown colour. Coral fragments do not appear to be very common, but in some of the upraised reefs molluscan remains are by no means rare. The limestones, in the majority of instances, are seamed with veinlets of carbonate of lime. Generally the structure of the coral has been destroyed by the action of infiltrating water. Instances, however, do occur—*e.g.*, at Misima—in which this is not the case. Here the base of one of the upraised reef masses consists of a chalky limestone, in which the remains of corals still exist. In most of the islands and localities examined, these elevated reef masses, when viewed at a distance, present the appearance of vertical walls and level terraces, stretching often for considerable distances. The faces of these cliffs are sometimes covered with vegetation to such an extent as to present the appearance of consisting of a huge wall of foliage.

The reefs raised only a few feet above the sea-level, such as those of Pannietta, present, along the shore, a white perpendicular cliff of varying height, above which is an almost level tableland, very broken and rugged, and with a very uneven surface.

Gigantic "swallow-holes" and enormous caves have been carved out of some of the limestones, and are lined with stalagmites and stalactites. The faces of the limestone cliffs are weathered into most rugged and sharp-edged forms, often presenting features of great beauty. The thickness of these reef masses I had no opportunity of ascertaining. It is, however, from the very mode of their occurrence, improbable that their vertical thickness can be very great. In the majority of the cases which came under my notice the various limestone terraces were horizontal, but at Ware (Teste Island) a marked peculiarity of the reef limestones was their arrangement in a series of gentle folds, the axes of which trended roughly north and south. In the Island of Einauro (Cette Island), two miles distant from the mouth of Losoa Doudou (Millport Harbour), the cream-coloured limestone had a dip of 50 degrees to the west-north-west.

The base of the upraised coral masses is not everywhere seen. At Ware (Teste Island) it rests upon a leaden-grey, slightly calcareous breccia, containing fragments of olivine. This breccia appears to resemble an ash.

On the Island of Misima (St. Aignan) a very interesting section, in one of the largest caves, shows the base resting on the upturned edges of the crystalline schists, with the intervention of a small thickness of what appears to be a partially consolidated volcanic ash. In another portion of the island, the base appears to rest directly upon the crystalline schists. Until the collection of fossils from these deposits has been examined it is almost impossible to adduce any reliable data as to the geological age of the raised reefs.

Kevori Grits. (A)

In the Kevori district, sandstones, grits, and conglomerates rest directly upon the Port Moresby Beds. These strata consist of fragments of quartz, slates, and volcanic rock cemented into rock by carbonate of lime. Some of the sandstone strata are much more calcareous than others.

The strata appear to have suffered but little disturbance since the date of their formation. They dip at a low angle to the north-east. As they are followed westward, the strata pass into conglomerate [77],* consisting of slate, quartz and volcanic rock cemented by carbonate of lime.

The position where these beds have been observed by myself has been indicated on Map No. 1. attached to this Report. It is not with any intention of correlating similar beds that it is stated that such are known to me from specimens presented to the Survey Collection at the following places:—Mailu (Toulon Island), the Divide between Tauwara (Milne Bay) and Pouro (Mullen's Harbour), and Red Cliff on the north-east coast of the Possession near the German frontier. That the Kevori grits are younger than those which have been called the Port Moresby Beds, and which are regarded by Mr. R. Etheridge, junr., as being Miocene or Pliocene Tertiary, is all that the meagre evidence at present collected permits us to say.

Port Moresby Beds. (K)

What have been called the Port Moresby Beds occupy a very considerable area of country. In giving a single colour to these I am conscious of the fact that this is done upon very meagre grounds. The absence of detailed mapping, and the impossibility of devoting any time to the search for organic remains, renders this grouping somewhat tentative. Chiefly on physical and lithological grounds I group the beds of Hall Sound, Port Moresby, and the adjacent coast line together.

The beds in the neighbourhood of Port Moresby consist of sandy limestones (containing foraminifera) and fine-grained calcareous shales, with thin bands of a buff colour. Black and yellow lenticular nodules of flint, with chalcedony, are of common occurrence in the neighbourhood of Port Moresby. In some of the limestone beds there can be traced a gradual passage from limestones into flint. The beds are generally vertical, or are inclined at high angles. In Camp Creek, a tributary of the Laloki,† these beds are seen to rest upon a coarse granite rock [9].

Similar beds to those of Port Moresby occur in cliffs along the coast as far as Kerepuna. These beds yielded me no fossils.

At Delena, on the south of Hall Sound, the strata consist of buff-coloured calcareous shales, sandstones, conglomerates, and thinly bedded and massive limestones, which yield fossils. The limestones are quasi-fragmental. On an exposed surface the rocks appear to be made up of sub-angular fragments of limestone. The

* The numbers in brackets refer to specimens collected.

† Laroki on the 1890 map.

The following fossils were obtained from the limestones:—

Gasteropoda—
Conus.
Turritella.
Lamellibranchiata—
Cardita.
Marginella ?
Pecten novæ-guineæ ? Ten. Woods.
Pectunculus.
Venus.

and fragments of indeterminable corals.

The shales yielded fragments of Echinoids and Molluscan Shells, to which, owing to the absence of sufficient palæontological literature, I have been unable to assign even generic names.

No estimate of the thickness of these beds could obviously be made. The age of the beds—at any rate those in the vicinity of Hall Sound from which the fossils were obtained—is clearly Tertiary.

The late Rev. J. E. Tenison Woods, in a Paper on "A Tertiary Formation at New Guinea"* (which I have been unable to peruse) described the "position and character" of the Hall Sound Beds. This was followed by another Paper on "Some Tertiary Fossils from New Guinea,"† in which a description was given of the new species *Pecten novæ-guineæ*; and the prosobranchiate Gasteropod *Dolium costatum.* Mr. Tenison Woods concluded that in these beds we have "a very recent Tertiary Formation, much newer than any of the Murray River or Western Victoria beds."‡

From the limestone beds lying beneath the Kevori grits in the Maiva District I collected a few fossils which yet await examination. The material collected by Mr. Edelfelt from the same localities was submitted to Mr. R. Etheridge, junr., who concluded that the Maiva Beds "are either Younger Miocene or Pliocene, probably the latter."§ Until, however, the suite of fossils which I collected have been critically examined by a palæontological specialist, it would be rash to endeavour to assign these beds to any special division of the Tertiary Period.

Boioro Limestones. (m)

What have been called the Boioro Limestones are best exposed in that headland in Launoka Doudou (Mayri Bay), from which the beds are named.

At Boioro, the limestones [65] are of a leaden-grey colour, and are seamed with veinlets of carbonate of lime. The weathered surfaces present a curious brecciated aspect difficult to describe. The bedding-planes, marked by lines of brecciated fragments (?) are inclined to the north-west at angles varying from 30 to 45 degrees. Some of the limestones contain flint nodules. Occasionally there is a gradual passage from limestone into flint.

A dyke of dolerite was seen to penetrate the limestones in the cliffs of Boioro.

Eastwards from Boioro, as far as Nobanoka Bay (Port Glasgow), the country was occupied by similar beds of limestone.

The Boioro Limestones yielded no organic remains; in fact, the time allowed at any particular spot was far too short to search for them.‖

On the very feeble evidence of lithological similarity, the limestones of Rogea (Heath) Island, and the mainland north of Samarai in the vicinity of Waiera Creek, are denoted by the same colour as those of Boioro. The Rogea Limestones [64] are arranged in thin beds in a small synclinical trough. The limestones of the mainland are identical in every way with those of Rogea. In neither place did they yield any organic remains.

The limestones of the mainland are penetrated by dykes of dolerite, and sections show what have every appearance of being interbedded dolerite sheets.

There is no evidence as to the age of the Boioro Beds. From their position they appear *prima facie* to be beneath the Port Moresby Beds, and they present totally different lithological characters to those presented by the latter. They are unconformably overlaid by the Recent Volcanic rocks.

The Boioro Beds are fully described later on under the head of "Detailed Description."

Metamorphic Rocks.

So far as at present known, the Metamorphic Rocks occupy a considerable area. Their position has been shown with as near an approach to accuracy as is possible on the accompanying maps.

The Metamorphic Rocks are separated broadly into two totally distinct divisions. The first includes what may be called the crystalline schists; and the second comprises all those other rocks in which the alteration has not gone on sufficiently far to conceal their derivative nature. To draw any hard and fast line separating the two divisions is quite impossible at present; and perhaps even with an increased knowledge of the geology of the country, the line may be found equally difficult to draw.

Igneous Rocks.

The Igneous Rocks form a very conspicuous feature in the geology of New Guinea. They may be grouped into three main classes—viz., Volcanic (lavas and ashes), Plutonic (granite, &c.), and Intrusive (granite, diorite, &c). Upon lithological grounds, the Volcanic Rocks fall into two primary divisions—the Acidic Series and the Basic Series; the former of which appears to predominate. Representatives of the Trachytic, Andesitic, and Basaltic Lavas, with their associated fragmental beds, were met with throughout the Possession.

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* Proc. Linn. Soc., New South Wales, 1877, pt. 2, p. 125.
† Proc. Linn. Soc., New South Wales, 1877, pt. 3, p. 267.
‡ *Loc. Cit.*
§ R. Etheridge, junr., "Our Present Knowledge of the Palæontology of New Guinea." Records Geol. Surv. New South Wales, vol i., 1889, p. 178.
‖ It may be that the Boioro Limestones, of Mayri Bay and Port Glasgow, are merely portions of an upraised coral reef. The adjacent Island of Cette is obviously of this nature.

From the fact that these rocks rest, with a violent unconformability, on the most recent strata, they cannot be of any very great age.

In parts of the D'Entrecasteaux Islands, and the north-east coast, near Collingwood Bay, modified forms of volcanic activity prevail at the present day. In the former locality, large areas of solfataras were encountered, and at Mount Victory—a cone of 4,000 feet in height—volumes of steam and smoke still issue.

Dolerites, diorites, and granite are known in the country at places indicated on the Maps.

DETAILED DESCRIPTION.

Port Moresby and Adjoining Country.

The cliffs in the neighbourhood of Port Moresby afford the geologist excellent opportunities of examining the rocks.

Bogirohodobi, or Paga Point, the eastern horn of Port Moresby, shows sedimentary beds dipping at angles varying from 35 degrees to 55 degrees to east 20 degrees north. The beds consist of sandy limestones, very much contorted and puckered, with thin bands of fine-grained calcareous shales. About 100 yards from the Point the contorted beds contain thin bands of buff-coloured shales. No band measured more than 2 inches.

South-west from Paga Point, and lying beneath all the other beds, are about 8 or 9 feet of blackish and grey sandy shales. These shales, which are approximately flat at the point where they are seen, form the crest of a broad anticlinal fold. None of the beds in this section yielded any fossils.

The western horn of the harbour and the islands Hanudâmava and Lolorua are of similar rocks and very much plicated. At Palipali Point, on the mainland, the sandy limestones dip east at angles of about 50 degrees.

Black and yellow lenticular nodules of flint, with chalcedony, are of common occurrence in these beds throughout the district examined. A gradual passage can be traced from some of the limestones into flint.

At a low headland on the mainland, bearing a little to the north of east from Tuaguba Hill, the sandy limestones, which are vertical, strike north and south.

In a traverse from Port Moresby to Warirata, on the Astrolabe Range, I saw, interstratified with these calcareo-siliceous rocks, thin beds of limestone on the weathered surfaces of which I did not detect any fossils. The strata were vertical.

The whole of the country traversed from Port Moresby to the Laloki River consisted of similar beds; near Fanny Peak, their strike is north 30 degrees west. In a little creek rising near Fanny Peak and flowing into the Laloki, these beds are seen to rest upon a volcanic rock of a basic type.

On my traverse to the Astrolabe Range I camped near the head of a small creek at 520 feet above the sea (which I named Camp Creek), bearing from Warirata 108 degrees, and Hombron Bluff 15 degrees. From the camp the Astrolabe tableland was seen to be made up of horizontally bedded rocks, which formed a bold escarpment several hundred feet in height. This escarpment is very conspicious even from a distance, and can be distinctly seen from the neighbouring heights of Port Moresby.

In the neighbourhood of the camp the ground was covered with huge blocks of conglomerate, made up of subangular pebbles of a fine-grained vesicular lava. These blocks were in all probability derived from the Astrolabe. In the tributaries of Camp Creek, buff and reddish shales, with siliceous bands were laid bare.

A traverse down Camp Creek to the Laloki showed an interesting section. A short distance below the camp, very much contorted shales dip at varying angles to the north-north-east. Lower down, on the north-western bank of the creek, a small landslip shows these shales resting on a coarse granitic rock [9]; this occupies the bed and bank of the creek for some distance.

Among the boulders in the creek, I saw a few of flesh-coloured and white limestone [72]. Similar limestones are seen *in situ* some distance above the junction of the creek with the Laloki. I was unable to satisfy myself as to whether these limestones belong to the same series as the buff shales, &c. The impression left on my mind was that they were of older date.

From the camp I ascended on foot, there being no other practicable way, to the summit of the Astrolabe Range. For some distance the road lay over country covered with blocks of volcanic conglomerate, beneath which reddish shales could be seen at intervals. On nearing the summit of the spur up which the track lay, we entered a belt of scrub, where, in a section exposed in the banks of a gully, the basement bed of the rocks of the Astrolabe could be seen. This consisted of a horizontal bed of fine volcanic ash, much weathered. The altitude of the base was, by aneroid, 2,060 feet above sea-level. From base to summit, this portion of the range consists of nothing but an enormous thickness of coarse volcanic conglomerate [10 and 11].

On reaching the edge of the tableland, and proceeding to the Village of Tabouri, about three or four miles distant, the track passes over nothing but coarse conglomerate. Tabouri is situated on the south bank of the Laloki River, some distance east of its junction with the Narino Creek.

From the Village to Narino Creek, which rises in the range to the south, nothing but sheet upon sheet of horizontal volcanic conglomerate is visible. The pebbles of the conglomerate are subangular, and vary very much in size. Their composition varies but little; they consist for the most part of basalt [10]. Passages from very fine-grained basalt to vesicular forms were observed.

My colleague, Mr. W. H Rands, in a "Report on Geological Specimens from New Guinea," dated June, 1891, thus describes the microscopic appearance of a "highly vesicular basaltic lava" from Warirata (Wata):—

"This rock is a dark-coloured highly vesicular basalt, the cavities in which are filled in with a zeolite which I did not determine. Under the microscope it is seen to consist of a brownish amorphous semi-opaque ground mass, through which are scattered numerous small prismatic crystals of felspar. Porphyritic crystals of augite occur, some of them very perfect in shape and showing very perfect cleavage. They contain enclosures of magnetite. There are some minute specks of what is probably olivine. Olivine is visible to the naked eye in some portions of the rock. Magnetite occurs in grains throughout the slice."

The

The rock thus described was in all probability merely a pebble from the conglomerate.

Between the Narino Junction and the Falls of the Laloki, the river forms a series of picturesque rapids, due to the water falling over the outcrops of some of the irregular bands of fine ash (of a greyish colour) which are interstratified with the coarser materials. Many fine perpendicular cliffs in the Laloki cañon give a good idea of the structure of these enormous ash beds. By the aid of field glasses, the inaccessible cliff at the falls on the north side of the river are seen to be made up of fine-grained beds, alternating with coarser materials, the latter predominating.

At the Laloki Falls, the river, which previously has flowed over the surface of these horizontal beds, suddenly plunges over the perpendicular escarpment, 300* feet in height, and flows down a magnificent cañon for over a mile, and after emerging from this it enters the comparatively open country.

Leaving my guide, Mr. Gleeson, the Overseer of Public Works in New Guinea, at a spot above the Falls, I climbed, accompanied by three natives, to the verge of the cañon at a place called Babera by the guides, in the hope of being able to trace the course of the escarpment to the northwards; but owing to the drizzling rain I was prevented from so doing. Looking down the valley from my coign of vantage, a bold scarp several hundred feet in height—Hombron Bluff—was seen to form the north-eastern end of the Laloki cañon. The whole valley on both sides of the river was covered with screes formed of immense blocks of ash.

From Tabouri I traversed the country to the south-east for a little distance, almost as far as the Divide between the Laloki and the head waters of the Kemp Welch River; the whole section was identical with that hitherto seen.

The official duties of Mr. Wriford, Commandant of the Armed Constabulary, who formed one of my party as far as Tabouri, took him to the Village of Sagara, about twelve miles to the east. Mr. Wriford informed me that the route he followed was over "conglomerate rocks" similar to those of Tabouri. From the highest point I ascended in the vicinity of Tabouri I could see tier above tier of either lava or conglomerate in the hills to the north-east, which I took to be the Richardson Range.

The result of my traverses from Tabouri showed me the inutility of examining any further the upper waters of the Laloki in the limited time at my disposal. Under these circumstances I decided to return to Camp Creek, where the horses had been left, and from thence to examine the country between it and the Goldie River, with the object of tracing the horizontal continuation of the conglomerate, and to ascertain, if possible, something of the nature of the underlying rocks; for it appeared to me that the possibility, or otherwise, of the successful search for metalliferous minerals depended almost entirely upon strata that lay underneath this enormous mass of fragmental volcanic rocks. (Fig. I., Plate III., shows a generalised section from Port Moresby to the Main Range.) Mr. Gleeson and I left the camp at the foot of the Astrolabe on our way to the Goldie River. The route we followed led us over a steep ridge to the north-west of our camp, composed of buff-coloured shales of the usual type. From the summit an excellent view of the Laloki Valley was obtained. No very serious difficulty was met with in finding a track down to the river, but some trouble was experienced in fording it. In the wash in the bed of the river were pebbles of schist, slate, and basalt, with an occasional pebble of limestone.

From the crossing, until a tributary of the Laloki, which joins it about three miles above the confluence of the Laloki and the Goldie, was reached, the country was composed apparently of nothing else than a coarse granitic rock identical with that described on page 12, as No. [9]. It was in this creek that gold was said to have been first discovered in New Guinea by a party of which my guide, Mr. Gleeson, was a member. The boulders in the bed of the creek presented no difference to those seen in any of the other creeks.

From the summit of the Divide between the Laloki and this creek, the bold scarp of the volcanic conglomerate could easily be followed by the eye for some distance up the creek.

To the Hiwick River, the staple formation consists of buff shales. I was carried across the river by two Papuans to examine the wash on the opposite bank. With the exception of the addition of a few pebbles of graphitic schist there was no difference to that in the other creeks.

Returning to where the horses had been left, we followed down the southern bank of the river for some distance until we met a native track which led us in the direction of the Goldie River. We crossed the river and remained all night at the old Digger's Camp, known to-day to the Europeans as the Seventeen-mile Camp.

From the camp to the crossing at the junction of the Goldie and the Laloki, we passed a few low hills of the Plutonic Rock [9] seen in the upper Laloki.

From the confluence, on the way into Port Moresby, I ascended a low conical hill bearing from Mount Lawes north 10 degrees west, and from Vetura north 10 degrees east. The hill, which had attracted my attention from a distance, showed bare white cliffs on its face, and consisted of grey limestone, doubtless interbedded with the rocks of Port Moresby.

Mount Lawes, as viewed from this point, appeared to be made up of some bedded rock dipping at low angles to the northwards. Two or three conspicuous escarpments could be seen on the southern face of Mount Lawes. Judging from the contour of the hill and the appearance of the rocks through a binocular, they clearly did not belong to the Volcanic Series; the discordant dips suggested an inconformability between the Mount Lawes Beds and those of Port Moresby. The face of a hill to the eastward of the track, from which the long grass had been burnt, showed vertical calcareo-siliceous beds trending north 30 degrees west.

On nearing the hills of which Mount Pullen is one of the highest summits, the track passed the foot of a spur, the face of which was covered with boulders of flesh-coloured limestone.

We returned to Port Moresby by the road which crosses Mount Pullen, by a low gap at the back of the London Missionary Society's Head Station. The range was found to be composed of siliceous limestone of the usual Port Moresby type.

Several cliff sections on the coast between Port Moresby and Kerepuna showed the staple formation to be beds of the Port Moresby type, all very much contorted. In its general aspect this part of the coast consists of comparatively low hills covered with long grass and stunted timber. Mr. Basil H. Thomson, at one time Private Secretary to the Administrator of British New Guinea, in a description of

* 900 feet according to C. R. Markham, in a Paper on "Progress of Discovery on the Coasts of New Guinea." Roy Geogr. Soc., Suppl. Paper, vol. i.

of the country passed over on horseback from Port Moresby to Kerepuna* says that:—"Some forty miles from Port Moresby the character of the country changes into a bolder and more broken formation of limestone hills covered only with coarse grass, and with belts of large timber on the watercourses. Some ten miles inland the Astrolabe Range, densely timbered, rises like a wall, to a height of 4,000 feet." This portion of the mainland I had no opportunity of examining, but in passing up the coast from the east end I was able to recognise the Port Moresby rocks in the cliffs, and I have but little doubt that the limestones referred to by Mr. Thomson are similar to those seen in the vicinity of the seat of Government.

On our way down the coast, in crossing what is marked upon the charts as Hood Bay, I could see, away in the distance, some low grassed hills, with fairly well-marked escarpments to the seawards, and sloping away gently eastwards. Sir Wm. Macgregor informed me that he had obtained fossils from these hills, but I did not see them. From the position of these hills I take them to be part of the Macgillivray Range of the charts.

I had no opportunity of visiting the country drained by the Vanapa River, but from specimens collected by the Administrator during his Expedition to the Owen Stanley Range, some knowledge of the geology of the district has been obtained. The specimens were submitted for examination to Mr. W. H. Rands, from whose report the following description is quoted:—

"The whole region consists almost entirely of schists, which become more highly metamorphosed as the loftier heights of the Musgrave Range and Mount Victoria are reached. On Mount Victoria the schists are very micaceous, highly crystalline, and closely approaching to gneiss. On passing down the river the country consists of clay schists and slates; while from near the mouth there are specimens of a but slightly altered sandstone.

"There are evidences of intrusive Igneous Rocks in the schists, but I have no information as to whether they occur as dykes or bosses.

"The specimens . . taken from a point between Mount Knutsford and Mount Griffith are of diorite, containing some needle-shaped crystals of hornblende."

From the hills below the junction of the Evelyn River with the Vanapa River, specimens of what are described as a "hornblende porphyry" were taken. "Thin sections under the microscope show porphyritic crystals of hornblende, decomposing orthoclase felspar, and magnetite."

The Mekeo (Saint Joseph) District.

During my short sojourn in the Mekeo (St. Joseph) District, owing to circumstances over which I had no control, geological work was rendered all but impossible. I was successful, however, in gaining a fair knowledge of the general geological features of a portion of the district, and an examination of a suite of specimens collected by Mr. Wm. Nettle when on an Expedition to Kovio (Mount Yule) under the leadership of Mr. George Belford, in December, 1890, enabled me to ascertain something of the nature of the rocks in the country at the head of the Paumomu (St. Joseph) River.

The St. Joseph (Mekeo) District, so named because it is drained by the St. Joseph (Paumomu) River, is situated in latitude 8 degrees 45 minutes, longitude 146 degrees 45 minutes.

In the Despatch (No. 60, May, 1890) with reference to a tour of inspection to the St. Joseph District, the Administrator of British New Guinea states that—"Some parts of the country, those nearest the sea, were visited by Signor D'Albertis in 1875; and the portions nearest to the mountain ranges inland were crossed by the Reverend James Chalmers, I believe twice, nearly half a score years ago. Many people have visited this part of the country since, chiefly prospectors; but Bishop Verjus and Mr. J. B. Cameron have given us a fairly correct idea of the main geographical features of the district. I believe that to Mr. J. B. Cameron is due the credit of having fixed the position of places in this district wherever that has been done by direct observation. His traverse of the river is also that on which the other maps have been based."

The districts mentioned below will be found on reference to Map No. 1 attached to this Report.

Geologically, the Mekeo (St. Joseph) District presents many points of interest.

In Hall Sound—the bay at the mouth of the Paumomu (St. Joseph)—fossils had been discovered by D'Albertis and Macleay in beds which have been referred by palæontologists to the Tertiary.† I had an opportunity of examining the locality from which the fossils were obtained.

Roro or Yule Island, charted by the "Rattlesnake" in 1849, which I first visited, is mentioned by D'Albertis as presenting "the appearance of a narrow tongue of land, about four miles in length, divided from the coast of New Guinea on the south-east by a channel about two miles and a-half in width. On the east and north it is separated from the mainland by Hall Bay (Sound) which is three to five miles wide. This island . . . . . consists of two small chains of hills which run along its entire length."

With reference to the geology, the same Writer states that—"the soil of Yule Island is calcareous, with volcanic base, and that it is of recent formation is proved by the coralline rock found in the highest peaks of the hills, while Igneous Rock is found in some parts of the shore. Leaving the sea and proceeding easterly the hills increase in height, and the coral formation is replaced by chalk, sandstone, and conglomerate."‡

I landed on the south-east coast of Roro and examined the section seen in the cliffs. This is depicted in Fig. II., Plate II.

(*a*) consists of a series of fine-grained calcareous sandstones dipping at 20 to 30 degrees to north, 45 degrees east. These beds contain fossils which are too fragmentary for transport. From one bed I was successful in securing a *Pecten*. Interstratified with these beds are what may be called "coral rags." They contain numerous fragments of coral, and a few pebbles of quartz and of some basic volcanic rock.

The

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* Thomson, B. H. "Narrative of an Exploring Expedition to the Louisiade and D'Entrecasteaux Islands," *Proc. Roy. Geogr. Soc. London.* Vol xi., No. 9, p. 526.

† R. Etheridge, junr., "Our Present Knowledge of the Palæontology of New Guinea." Records Geol. Surv. New South Wales, vol. i., 1889, p. 173.

‡ D'Albertis, New Guinea. London, 1881, vol. i., p. 401, *et seq.*

The two small chains of hills running along the entire length of the island, referred to by D'Albertis, are formed by the outcrop of some of the beds of this series which are better able to resist denudation.

(*b*) is the remains of a raised gravelly beach, the base of which is 4 or 5 feet above high-water mark. The gravel is of a leaden-grey colour, and is crowded with fossils, a collection of which I made. Unfortunately these have gone astray.

(*c*) is a basaltic lava seen on the beach; this appears to emanate from one of the high hills which stand out prominently between the two escarpments of the sedimentary rocks.

I had no other opportunity of examining the structure of the island. Among some specimens from Yule Island, presented by the Administrator to the Survey Collection, are some limestones containing fossils which yet await examination. In their general character they approach very closely to the Delena Limestones described below.

At the village of Delena, on the south of Hall Sound, I examined a section in the cliffs to the north. A sketch of this is given in Fig. III., Plate II.

In this section (1) consists of buff shale, sandstone, and conglomerate dipping north-east, separated by a fault from (2) buff-coloured clay shales containing fossils. Proceeding northwards along the coast, the beds become vertical, and a fault divides them from (3) a mass of thinly bedded limestone, with bands of clayey shales.

These limestones yielded the following fossils:—GASTEROPODA: *Conus*, *Turritella*. LAMELLIBRANCHIATA: *Cardita*, *Marginella* (*?*), *Pecten*, *Pectunculus* (*?*), *Venus*.

In the upper portion the clayey shales predominate; these also yielded a suite of fossils yet unexamined.

(4) At the north-east end of the section is a massive white coralline limestone, separated by a fault from (3).

A curious feature with reference to the limestone is its mode of weathering. On an exposed surface it appears as though the rock were made up of subangular fragments of limestone. Such quasi-fragmental rocks are by no means uncommon in other coral reef districts. Professor J. D. Dana, in describing the reef-rock of coral islands, says that some parts are compact solid limestone, "but generally the rock is a breccia or conglomerate made up of corals cemented into a compact mass."*

In the Solomon Islands, Dr. H. B. Guppy found that the so-called coral limestones "are usually white in colour, but sometimes reddish or yellowish-brown, hard, compact, but at times crystalline in texture, and now and then displaying a fragmental structure. They are chiefly made up of crystallised carbonate of lime and fragments of corals, molluscan shells, serpula tubes, echinoderms, calcareous algæ, and other organisms, whilst the interstices are filled with tests of foraminifera."†

The limestone of Delena is crowded on its weathered surface with organic remains, corals being conspicuous by their comparative rarity. The whole of the rocks in this section have the same general lithological character.

During my visit I examined the Maiva District, south-east of Cape Possession. "The hills lying behind Maiva run westward inland of Kevori, and then sweep round to the south, where they meet the sea at Cape Possession."‡

Approaching these hills from Maiva by the road to the Village of Aipeana, after crossing a tidal swamp, the track along the seaward face is strewn with pebbles of carbonate of lime, some basic volcanic rock and coral limestone, with occasional boulders of sandstone formed by volcanic *débris* cemented with carbonate of lime. A little way up the face of the hill a very calcareous sandstone is seen *in situ* dipping at a low angle to the north-east. As these beds are followed west they pass into a very coarse conglomerate [77], consisting of pebbles of slate, quartz, and volcanic rock cemented by carbonate of lime. Beneath this, a coralline limestone, passing into a kind of marl, with undetermined fossils, is seen to rest.

"The collection of the Queensland Geological Survey has been enriched by the presentation by Mr. E. Edelfelt of specimens of brown or yellow marl from Maiva Village, found at a height of about 200 feet above sea-level. The marl has plentifully scattered through it the remains of small shells in the form of internal casts, and a few fragmentary corals."§ Among the Maiva collection, species of *Alveopora*, *Leptoria*, *Galaxea*, and *Deltocyathus* were recognised. Mr. Etheridge states that Mr. Edelfelt's Maiva collection is of "too limited a nature to permit any definite statement to be made as to the age of the beds; but they are either Younger Miocene or Pliocene, probably the latter."‖ From the appearance and position of the Maiva Limestones, I incline to the belief that they are identical with those of Delena.

From Maiva I walked, *viâ* Aipeana, to Mekeo, the headquarters of the Government Agent. The aspect of this district is admirably described by the Administrator in one of his Despatches, from which I quote:—

"When we reached the top of the range of the low hills north of Maiva, our course was directed towards Mount Yule nearly in a north-easterly direction to the Village of Aipeana. From the top of the range a good view is had of the fine rich flat plains of the St. Joseph, lying between the great main range parallel to each other at a distance apart of probably 20 miles. Our road lay at first along the spurs of the coast range, which rises at no place to over 1,000 feet. In the hollows between these undulating hills the Maiva people have many gardens, some of them quite half a dozen miles from their villages. The ground is fertile, but as might be expected, there is no great quantity of planting land at any particular spot among the hills. The distance traversed between Maiva and Aipeana is about 14 miles, all over level country, with good soil after leaving the Maiva hills. There are some three or four swampy creeks, to cross which would give some trouble in making the track a bridle path. There is no old forest on the way The whole of the flat land between the two villages has been cultivated at no very remote date."¶ A generalised

* Dana. "Corals and Coral Islands," 3rd edition. New York, p. 175.

† Guppy. "The Solomon Islands, their Geology, &c." London, 1887, p. 74.

‡ Despatch 69, 1890, par. 2.

§ R. Etheridge, junr. "Our Present Knowledge of the Palæontology of New Guinea." Records Geol. Surv., New South Wales, vol i., pt. iii, p. 177.

‖ *Loc. cit.* p. 178.

¶ Despatch, 69, 1890, par. 4.

A generalised section across the Maiva Hills is shown in Fig. I., Plate II.

To Mr. George Belford, the Leader of an Expedition to the summit of Kovio (Mount Yule), is due the credit of having given some additional information with regard to the geography of the Kovio Range. A summary of the results acquired by the party is given by Sir Wm. Macgregor in a Despatch referring to the Expedition. The paragraphs, which make the remarks with reference to the geology more intelligible, will be found under the head of "Physical Geography."

My intention had been to make some personal aquaintance with the district described by Mr. Belford, but owing to the disturbed state of the country that design was, to my great regret, frustrated. With reference to this, Sir Wm. Macgregor, in a Despatch relating to a visit of inspection to the Mekeo District states, in paragraph 5:—"As it was my intention that the examination in the interior in the direction of Kovio (Mount Yule) should be followed up, I had brought from Port Moresby a small party equipped for that purpose; but all thought of doing so at the time was abandoned, because it was manifestly necessary that the authority of the Government should at first be securely established in Mekeo, and, moreover, the weather was too wet, the grass too green, and the rivers all too much swollen for travelling."*

A suite of specimens collected by Mr. Wm. Nettle, the Prospector who accompanied Mr. Belford's party, were submitted to me for examination, and a report upon them was published in the *British New Guinea Government Gazette*, from which the following details are taken.

The notes contain merely a short account of the lithological character of some of the various specimens collected by Mr. Nettle when on an expedition to Mount Yule in the month of December, 1890. Without any notes as to the mode of occurrence of the rocks in the field, the information afforded by them is somewhat meagre, and any conclusions drawn from such scanty evidence would not be of much value. The collection consists of twenty bags of rocks and other specimens.

A few of the Volcanic Rocks are remarkably fresh, but the majority have suffered very much from weathering, and also in transit. A rock collected on 6th December from Mount Drew (the country in the vicinity of which Mr. Nettle in his notes accompanying the specimens describes as all volcanic) is of a pale reddish colour, with a matrix containing scattered through it well-formed crystals of augite. An estimation of its specific gravity gave a mean result of 2·4. Before the blow-pipe it fused with ease to a dark-coloured enamel. Its general macroscopic characters approach closely to those andesites which are a distinguishing feature of some of the volcanic outbursts in the islands of the Eastern Archipelago.

Two bags of specimens were collected from the foot of Mount Drew. One bag contained a rounded pebble which gave a specific gravity of 2·44. When broken open and examined, the rock is found to have a dark-coloured matrix, with crystals of augite scattered through it. Some portions, probably vesicles, are crowded with a zeolitic mineral (chabazite?). This rock agrees very well with that above described, and may also be referred to the augite-andesites. In the second bag was a rock which differed in many points from those above mentioned. The difference in specific gravity is such as can be ascertained by mere handling; an estimation gave a result of 2·84. The rock is fine grained, compact, and of a bluish-black colour. It contains small olivine crystals. Without the aid of modern refinements of petrography, the rock would undoubtedly be classed with the olivine-basalts.

From the weathered and friable nature of the specimens contained in the bag labelled 25-12-90., and which Mr. Nettle's notes allude to as having been obtained from the summit of Mount Yule, the rocks are somewhat difficult to describe. The unaided eye shows a dark-grey matrix, containing some zeolitic mineral and a greenish alteration-product—probably the result of the decomposition of augite. The specific gravity, by mere poising in the hand, is felt to be low; this, however, may result from decomposition. Such meagre evidence as is to be obtained by a comparison of the whole of the collection, points to the rock being merely an unusually decomposed andesite.

On December the 26th, two bags of rock ("Sandstone" of the notes) were gathered from one of the spurs in the flanks of Mount Yule. The only specimen received is very friable and of a reddish-yellow colour. It is merely an unusually decomposed fragment of a rock similar to that obtained from the summit of Mount Yule.

From a small creek, visited on December 27th, taking its rise from Mount Yule and said to be about six yards in breadth, specimens of weathered andesite, a clayey sandstone, and a milk-white quartz (in which neither gold nor other mineral was visible) were obtained.

A fragment of augite-andesite similar to that described from the foot of Mount Drew, was obtained on the 29th December from one of the leading spurs of Mount Yule.

The wash-dirt collected from the bed of what is called No. 4 River, is made up of a large percentage of magnetic oxide of iron, with particles of olivine (?) and felspar. This sand is doubtless derived from the denudation of some volcanic rock.†

Whilst the remainder of the party were engaged upon their official duties at the Village of Inawaia, I left the Village of Inawabui, where we had made our headquarters, with the object of reaching a low range—the Isabella Hills—almost due west of us.

On reaching the foot of them after a long tramp across two or three nasty swamps, I ascended a bare cliff, from which I overlooked an extensive plain studded with swamps. This plain appeared to extend for miles along the coast. The section on the cliff showed a coarse volcanic conglomerate of basaltic *débris*, lying horizontally. This resembled very much the conglomerate of the Astrolabe Range. Judging by the lie of the country, this conglomerate appeared to occupy a considerable area.

Mabaduan District.

My last work in New Guinea was at Mabaduan, a small hill near the mouth of the Pahoturi (Kaiva Kussa River), and north of the island of Saibai, in Torres Straits. This is the only elevated country in British territory west of the mouth of the Fly River. It is here that the Resident Magistrate of the Western Division of British New Guinea has his headquarters.

The hill, Mabaduan, said to be about 160 feet in height, is composed entirely of granite. The area occupied by the granite is very small. Mr. W. H. Rands, in a Report dated June, 1891, describes the microscopic appearance of a granite from Mabaduan "containing large porphyritic

* Despatch 75, 1891, par. 5.

† A. Gibb Maitland. "Notes on some Geological Specimens collected in British New Guinea in 1890-91." *British New Guinea Government Gazette*, vol. iv. No. 6, June, 1891.

porphyritic crystals of felspar," in the following terms:—"This rock, in a thin section under the microscope, shows some very fine crystals of oligoclase felspar, exhibiting very beautiful repeated twinning; other crystals of felspar have become kaolinised owing to decomposition. The felspar was evidently the first mineral to crystallise out, as the other minerals are arranged around it. Quartz occurs in large blebs, which appear to have been broken up into smaller rounded and irregular-shaped particles, which polarize in different colours, and are full of minute stone enclosures. Mica (biotite) is plentiful. It has become peroxidised in places into ferrite."

During my stay in the north of Torres Straits I had the opportunity of examining the Island of Duan (Cornwallis Island), situated about five miles from the New Guinea coast. This is the only island in Torres Straits of which I have any personal knowledge. The island is lofty, and the highest point, according to the Admiralty charts, rises to 795 feet above the level of the sea. The whole of the hills are covered with hugh boulders, which weather after the fashion characteristic of granitic rocks. So far as I was able to see, the whole island was composed of a coarse-grained granite, identical in its general macroscopic characters with that of Mabaduan on the mainland.

The rock (2) contains an abundance of flesh-coloured felspar, mica, and hornblende.

Throughout the main mass there are dykes of granite of a much finer grain (1, 3).

(1) is a very fine-grained steel-grey rock containing horneblende. (3) is of a grey colour with crystals of quartz and felspar set in a matrix of a similar composition, but of a much finer grain.

The foreshore of the east end of Duan is formed of "beach sand rock," some parts of which are very ferruginous. This rock, so far as could be seen, was lying quite horizontal.

On our way to Thursday Island we passed close under the west side of Gabba Island (The Brothers). With the aid of a binocular it was easy to see that this island was also granite.

Further south we steamed within a quarter of a mile of the eastern coasts of the islands of Suaragi (Burke), Nagheer (Ernest), and Getullai (Pole). Judged by their contour, and by the enormous parallelopipedon-shaped boulders, they appear to be composed also of granite.

The Country Between Cloudy Bay and Milne Bay, with a Description of Some of The Adjacent Islands.

The Cloudy Bay District is one to which unusual interest is attached. Upon the Admiralty charts there is marked a river—the Robinson—flowing into the head of Cloudy Bay. Judging from the features of the country as delineated on the chart, the Robinson drains the range of mountains of which Mount Suckling, 11,226 feet, appears to be the highest summit.

In the latter end of the year 1889, the Cloudy Bay District was visited by the Administrator and his party for the purpose of capturing the perpetrators of the murder of two Europeans. Some time was spent by the party in visiting the villages and a few of the rivers which enter the sea in that neighbourhood. A partial ascent was made up the Domarawai, Oini, Duranu, Gidoguina, Oagunia, and the Riguina Rivers. Owing, however, to the strength of the party being weakened by fever, the ascent of the Robinson had to be delayed.

The Riguina did not extend any very great distance inland. About 2½ miles from its mouth it was found to break up "into a large number of small creeks spreading out between conglomerate hills." The other rivers were found to have similar endings.

I accompanied the Administrator, in May, 1891, up to the head of an unvisited branch of the reputed Robinson River. The "Merrie England" was anchored off Dedere, or Columbier Point, and our party left the ship in a whaleboat towed by the steam launch. Just inside the entrance to the estuary of the Robinson River, we visited some rocks which were seen rising just above the water level. The rocks, apparently covered, or nearly so, at high water, of which a few specimens [15] were taken, are of a chocolate colour and very vesicular. They are portions of a basic volcanic rock. A point on the mainland—Gobruru—on the western bank of the river, is of a similar nature.

To the east of the entrance of the Ruguina there occurs a low, razor-backed ridge of basic lava. At the junction of this ridge with the mangrove flat, a party sent out for the purpose found a supply of fairly good water. Further up the river a rocky point projects; this is formed of a coarse volcanic conglomerate, the pebbles of which are similar to those of the lavas [12, 14] of which the scrubby hills behind are composed. I ascended one of the latter close to the rocky point to an altitude of 250 feet, but was unable to get a view of the surrounding country.

We followed up all the branches of the inlet at the mouth of the river to their head, and were reluctantly driven to the conclusion that no Robinson River exists. That the drainage of the Main Range must fall into Table Bay was the only conclusion at which we could arrive, and our efforts were next turned in that direction.

On our way from the mouth of the Ruguina to the ship, I had an opportunity of examining a portion of Abau Island, whilst a portion of the crew were searching for water for the use of the launch. On the north shore a steep bluff exposes buff-coloured lavas [16,* 17, 18] of intermediate composition. These beds lie horizontally.

Leaving Dedere, the "Merrie England" steamed across Baxter Bay and dropped anchor a little to the west of Batumata, or Table Point. A party of us landed, and after taking a round of angles the Administrator, Mr. Hatton Richards (the Colonial Treasurer), and myself walked along the beach for about three miles, where we found a brackish water lagoon, probably the mouth of a creek banked up by sand. The position of this was indicated by the following bearings:—Table Point, 222 degrees; Inskip Hill, 60 degrees. In vain did we search with the glasses for any sign of the mouth of a river. The bay was seen to consist of nothing else than a sandy beach of several miles in extent, with a considerable extent of low, wooded country behind.

On our return to the steamer the anchor was raised, and we steamed slowly across the bay, passing Onibu Cliffs, where a bedded rock (limestone?) could be seen dipping at a high angle to the east. I had no opportunity of going ashore to examine this section.

The

* Analysis of No. 16:—Silica, 54·95; Alumina, 22·03; Iron Protoxide, 7·52; Manganese, 0·11; Lime, 7·32; Magnesia, a trace; Potash, 2·39; Soda, 4·30; loss on ignition, 1·18.

The steamer dropped anchor in the Amazon Group, between the island of Ainoro and the Kwaipamatu Point, the western horn of Selai Doudou (Amazon Bay). From Ainoro I was able to make a traverse of Mayri and Amazon Bays. Leaving the steamer at anchor, I first paid a visit to the island of Laraoro, which lies due north of Mailu (Toulon) Island. The position of Laraoro is properly indicated on the Admiralty charts, but no name is given to it. The island is very low, sandy, and wooded. Within a short distance from the shore, the coral reef which surrounds the island plunges precipitously down into very deep water. With the single exception of an exposure of "beach sand rock" on the north-east side of Laraoro, no other rock was seen on the island. The beach sand rock dips at a low angle to the seaward. From Laraoro our party steered for a conspicuous rocky headland in Launoka, carrying a line of soundings *en route*. We learned from the natives that the headland was called Boioro.

On reaching Boioro I landed on that portion of the coral reef left dry by the falling tide, and soon reached the foot of the precipitous cliffs which form a prominent feature in the landscape. These are composed of limestone [65] seamed with thin veinlets of carbonate of lime. The weathered surface of the limestone presents a curious brecciated aspect difficult to describe. The bedding-planes, marked by lines of brecciated fragments (?), were inclined to the north-west at angles varying from 30 to 45 degrees. Though I searched carefully on the weathered surfaces during the few minutes I was allowed to remain ashore, I detected no trace of organic remains. Below high-water mark the limestone weathered into greyish rounded lumps. Some portions of the limestone contained flint nodules; in some places a gradual passage could be traced from limestone into flint.

As we skirted the precipitous cliffs of Boioro, I saw in one place an almost vertical dyke of dolerite (?) penetrating the limestones. We crossed the little inlet of Amrra Doudou, and landed on the beach of Ebu Doudou.

The bay of Ebu is encircled by fairly high ranges. I ascended a spur of these to an altitude, by Aneroid, of 1,650 feet above the beach.

In my traverse to the Village of Derebai, no other rocks but massive diorite [20], of a greenish-grey colour, were met with. The village is built upon a rocky conical hill (1,650 feet in height) of diorite.

From Derebai an excellent view of the Main Range was obtained. I saw also to the north-north-west an extensive grassy timberless flat at the foot of the range. This plain appeared to be drained by a river, probably opening into Selai Doudou (Amazon Bay). From the general position of the ranges and configuration of the country, I incline to the belief that this watercourse is the one which drains the southern flanks of Mount Suckling; in fact this may be the missing Robinson River.

Reaching the beach again, the boat at once put off, crossed Selai Doudou, and landed the party at the Village of Kurere, situated on a sandy spit at the mouth of a fairly large river, called by the natives the Bomu. My intention was to have ascended the Bomu in the launch for some distance; but unfortunately the boat grounded, and it took us some time to get her off. Where we grounded, the general course of the creek was north 6 degrees east. The volume of water coming down the Bomu was not large, and the current was not very strong.

From the anchorage at Kwaipomatu Point, I proceeded by steamer to Launoka Doudou (Mayri Bay), and on landing visited Borebo under the guidance of Biari, the Chief of the village. Borebo is situated on the divide between Losoa Doudou (Millport Harbour) and Launoka Doudou, at an altitude of about 800 feet from the beach. It is approached by a very precipitous path. From base to summit the prevailing rock was limestone of the Boioro type. The beds appeared to be vertical; they contained lenticular and branching veinlets of calcite, stained red in places by oxide of iron. These limestones appeared to lie below those of Boioro.

From Losoa Doudou I was able to pay a hurried visit to the island of Einauro—Cette Island of the Chart—distant about 2 miles from the mouth of the bay. Viewed from a distance, this island presents to the east an almost vertical cliff of some considerable height, and appears to be formed of basalt. On landing I examined the cliffs at the western end of the island, and found them to be composed of cream-coloured limestone [71], which showed no trace of coral origin to the eye. Occasionally the solid limestone was seamed with calcite. The whole of Einauro is apparently of similar limestone. The limestone, however, is totally different to that seen in the cliffs at Boioro and neighbourhood. Einauro may be regarded as an elevated coral island, of which I saw many examples in the Louisiade Archipelago at a later stage of my travels.

From Losoa Doudou I was also able to see something of the constitution of the headland dividing Mayri Bay from Millport Harbour. To do so I made a traverse from the beach to the Village of Pediri, "on the top of the hill east of the entrance to Losoa, at an elevation of 800 feet."*

The whole section, from base to summit, shows nothing else than limestone of the Boioro type. At a spot about 800 feet above sea-level, two isolated boulders of granite were seen in the vicinity of the village, resting on the limestone. They were too large to have been transported there by human agency.

Returning to the "Merrie England," we proceeded to Nobanoka Bay (Port Glasgow), in the vicinity of which I examined a few sections. Under the guidance of Barau, the Chief of the Village of Vere-vere, off which we anchored, I visited the summit of Geaoro, the western horn of the harbour, where were the remains of an old village. The section from base to summit was limestone of the usual type. The whole of the country in the vicinity of Port Glasgow was also of limestone. The island of Barbara, in Orangerie Bay, I had no opportunity of visiting; but it is described by the Administrator, who visited it on the 9th of June, 1891, as being "chiefly a mass of forest-covered limestone."

Crossing Orangerie Bay, the "Merrie England" dropped anchor off the Village of Isikokoira, on the north coast of the island of Mugula (Dufaure).

Accompanying the Chief Judicial Officer (Mr. Winter), and the Colonial Treasurer (Mr. Hatton Richards), I made a short excursion into the interior of the island. A rocky spit near our landing place exposed coarse andesitic agglomerate [25], the fragments in which were of a very vesicular andesite. I detected no signs of stratification in this section.

A conversation with Mago, the Chief of Isikokoira, procured us guides to the summit of the range of hills behind the village. A track which we followed to the summit of a peak, to which the natives gave the name of Koado, showed that the staple rock was andesitic lava [26]. The altitude, by Aneroid, was

* Despatch 46, 1891, par. 13.

was 1,270 feet above the sea-level. From Koado, a long ridge, running almost due east and west, led to another peak, Logologoma, 1,260 feet in height. This was composed of a similar volcanic rock. To the Village of Isikokoira we returned by another route, which enabled me to ascertain that the structure of the Koado Range is similar throughout.

On the following day, with Mr. Winter, I made a traverse along the coast as far as the village of Guiagori, which forms the northern end of Moisi Bay. Numerous rocky headlands show andesitic lavas and agglomerates to be the prevailing rocks. In some portions of the rocks, fragments of amygdaloidal andesite were seen.

On the 8th of June, a party, consisting of the Commandant, some members of the Armed Constabulary, and others were landed at Were-were in Pouro (Mullens Harbour),* to effect the arrest of a murderer at Sila-sila. I was instructed to accompany the party, and to make such an examination of the geological features of the country traversed as was possible.

Exposed in the cliffs along the beach at our landing place at Were-were were some porphyritic basalts [27, 28].† The beach was covered with black sand, due to the disintegration of the Volcanic Rock.

Having secured porters, the party left Were-were for the village of Wabumari, at the head of Cabusaurea (Meikle) Bay, where our headquarters were to be made. Our track lay generally south, over well-timbered and rich soil country. The whole country, judging from isolated sections, seen *en route*, consists of a Porphyritic Volcanic Rock of comparatively high specific gravity, and which I take to be a basalt.

From Wabumari, I examined the sections in the cliffs of the eastern horn of the bay. At the little village of Sariba, virtually a suburb of Wabumari, a small creek, which drains the volcanic focus of Watiapoa, enters the sea.

At a rocky headland on the beach, bearing from Erima 310 degrees and Watiapoa 35 degrees, a greenish-grey andesitic lava is exposed [22]. From this point, Erima is seen to be a typical volcanic focus, from which a well-marked lava stream has emanated and flowed across the country behind Wabumari.

To the Village of Waru, at the head of a small bay, andesites of the usual type prevail. They are penetrated by small dykes of a similar nature, but of a much finer grain.

In the vicinity of Rekoa, some of the andesites are amygdaloidal [23], the amygdules being filled with a zeolitic mineral.

The country between Wabumari and Sila-sila, as ascertained by a traverse between the two places, is of the same geological constitution as that between Wabumari and Were-were.

In the cliffs on the beach between the Village of Suaiaro and Aboboma, andesitic lavas, penetrated by finer grained dykes, were the prevailing rocks.

From Cabusuaiaru Bay, the "Merrie England" proceeded to Suau, one of the stations of the London Missionary Society, and dropped anchor in a deep-water channel between it and the mainland. The cliffs along the coast to the north showed nothing but coarse volcanic agglomerate, with rude traces of bedding. Passing along the coast, from the deck of the "Merrie England," several hills on the mainland were seen to have all the appearance of volcanic foci.

With reference to this subject, I cannot refrain from quoting a passage in the first volume of Macgillivray's "Voyage of H.M.S. 'Rattlesnake'" (page 70), in which it is observed that—"The fact of the existence of several active volcanoes on islands immediately adjacent to the north coast of New Guinea (first made known by Dampier), and the circumstances of volcanic bands traversing the length of many of the great islands of the Malayan Archipelago and others, as far to the southward as New Caledonia and New Zealand, rendered it extremely probable that we should have found indisputable signs of comparatively recent volcanic action in the south-east part of New Guinea. We saw no volcanoes, however, and the great central mountain chain appeared to me to be probably granitic."

The largest of the Brumer Islands, which I had no opportunity of examining, is stated on the same authority to be of volcanic origin; and is said to consist of—"a stratified earthy tufa and volcanic conglomerate hollowed out below by the sea, succeeded by a harder vesicular rock, above which one of the forms of lava has been poured out."‡

Samarai (Dinner Island), the headquarters of the Magistrate for the Eastern Division of the Colony, was reached the same day after leaving Suau.

On the south side of Samarai, close to the new gaol, a section, visible at low water, shows a bluish-green dolerite, penetrated by dykes of a porphyritic rock [29, 30, 31], which contains black prismatic crystals of hornblende. Dykes of a similar nature are to be seen at intervals all round the coast of the island. They do not appear to have any prevailing direction, and their thickness does not appear to be great. At the north end of Samarai, a coarse doleritic agglomerate takes the place of the bluish-green lavas, showing that in all probability the island is a portion of an extinct volcano.

From Samarai I paid a visit to Rogea (Heath) Island, landing at the Village of Mabassi (?). Some bare rocks, of a compact bluish-green colour [33], were exposed on the beach. These appeared to resemble the dolerites of Samarai.

From Mabassi to the Village of Rogeapata (?), dolerite of the usual type occupies the coast. I skirted the coast from Rogeapata (?) to a large bay, which, as far as I could gather from the natives, through interpreters, was called Karaga (?). Entering this bay from the north, and crossing a small creek which disembogues at this end, no section is seen for a considerable distance. Some cliffs, from which Samarai bears north-north-west, expose rocks identical in every respect with those seen at, Mabassi (?).

The western headland of Karaga Bay shows the dolerites to be penetrated by dykes of a rock [34] of a greyish colour, of which mica appears to be an important constituent.

Some little distance round the headland to the west, an instructive section is laid bare. Resting directly upon the Volcanic Rocks is a series of platy fissile limestones [64] of a leaden-grey colour. The beds, nowhere very thick, are arranged in a small synclinal trough about 40 feet across. The section is depicted in Fig. IV., Plate II.

Subsequent

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* Despatch 46, 1891, par. 18.

† Analysis of No. 28:—Silica, 48·76; Alumina, 20·46; Iron Protoxide, 9·54; Manganese, a trace; Lime, 10·41; Potash 1·38; Soda, 5·55; Loss on ignition, 2·53.

‡ Macgillivray, "Voyage of H.M.S. 'Rattlesnake,'" vol. i, p. 266.

Subsequent to my visit to Rogea I was able to make a hasty traverse of a portion of the mainland to the north of Samarai. In company with Mr. R. E. Guise, the Naturalist, who was temporarily attached to the Administrator's staff, I landed at the mouth of a big creek, which the natives accompanying us called Waiera (?).

About a mile from the coast, on the north bank of an important tributary of Waiera Creek coming in from the northwards, the first rock seen *in situ* was a bluish-green dolerite [32], which weathered in places into spheroidal nodules. The rock had a conchoidal splintery fracture and a fairly high specific gravity. For some distance the waters of the creek flow over nothing but a similar dolerite. At an altitude of 100 feet above sea-level, a platy fissile limestone [63], similar to that of Heath Island, dips at a low angle to the east, and rests on dolerite. No organic remains were detected in any of these limestones. In one place they are penetrated by dykes of dolerite. A quarter of a mile above where the first exposure of limestone is seen, a section showed a small lenticular bed of limestone between two sheets of dolerite; the limestone was apparently unaltered. This section is shown in Fig. II., Plate III.

My knowledge of the geology of the isthmus dividing Tauwara (Milne) Bay from that of Pouro (Mullens Harbour) was derived from a journey across country with the Administrator, in the month of August, 1891, starting from Maivara.

Leaving the steamer at the low coral island of Aleford, our party rowed up Maivara Creek, and landed on the left bank at a small village which was in course of erection. From this point our route led us generally south-west, over low-lying country. We reached a large fresh-water creek, which I took to be a tributary of the Maivara. We crossed the creek in canoes, and followed up one of its branches to the head, on the divide between the two bays. This dividing range—Kaisabu of the natives—is crossed at an altitude of about 800 feet.

Until the head waters of Maivara Creek were reached no geological section was seen. Andesitic lavas and agglomerates, overlaid by coral limestones, formed the whole of the range.

After leaving the range, I saw no section until Sagara was reached. Between Sagara and Tamora the country is occupied with lavas and ashes of the andesite type. The surface of the flat country was covered in places with a deposit described as "an iron oolite consisting of agglutinated concretions of iron peroxide and *débris* of the same."*

At Apia, canoes were obtained to convey the party to Were-were. Some little time was spent at Were-were, and from thence canoes conveyed us to Dahune. In a cliff section near Dahune I saw, in passing, stratified lavas and ashes.

The North-east Coast.

My knowledge of the geology of the north-east coast was obtained from an examination of a portion of Awaiama (Chad's) Bay, Tauputa, and the northern flanks of Mount Suckling, and the study of a suite of specimens collected under the direction of the Administrator, in the vicinity of the German frontier.

I landed with the Administrator and Mr. B. A. Hely, Magistrate of the Eastern Division of the Colony, near the village of Awaiama, and, while the Administrator was engaged upon other duties, endeavoured to ascertain something of the constitution of the hills in the vicinity. The beach was strewn with fragments of a basic volcanic rock. Before I was able to get near enough to see the rock *in situ* in the hills, the party was suddenly recalled to the ship. I was sufficiently near, however, to observe that some of the hills were composed of a coarse, apparently stratified, sand.

From Awaiama we skirted the coast, and I obtained a view of the conspicuous cliff of Gariruru, the proposed site of the Anglican Mission Station. No opportunity of visiting the place presented itself, but the Administrator describes it as "presenting to the sea a coral rock cliff about 100 to 120 feet high." Leaving Gariruru, we passed Emurimuri Point and dropped anchor off Tauputa. Here I landed, and found a cliff of coral limestone at the sea-level, and a conglomerate formed of coral *débris*, mixed with pebbles of the volcanic rock with which the beach is strewn.

With the intention of examining the hills behind Tauputa, I landed one morning and secured the services of a few natives (with whom I was unable to converse) to carry my impedimenta. I entered a small creek—Menoua (?). About a mile from its mouth, and close to the eastern bank of the creek, a cliff—Gaubara (?)—about 80 feet high, exposes a great thickness of stratified sand and gravel, with boulders of volcanic rock and coral limestone. Similar sections were seen at intervals in the banks of the creek.

To an altitude of 760 feet, the track followed the watercourse closely. The sections at several of the cascades (which are very numerous) showed only basic lavas of the usual type, lying apparently horizontally. At about 800 feet above the beach these beds were overlaid by a horizontal coral limestone [70], similar in character to that seen on the beach. At 400 feet there were horizontal basic lavas, which were covered, at an altitude of about 2,000 feet, by a white coral limestone, which formed a very conspicuous feature in the landscape, and was called by the natives Korada. I detected no fossils in these limestones.

From a conspicuous point on a spur, at 1,400 feet above the sea, a cliff, called by the natives Wara-wara, bore 262 degrees 30 minutes. This was distant about a mile. It formed a conspicuous escarpment to the seaward, and, from its peculiar mode of weathering, appeared to be limestone of the Korada type.

I returned to the coast down a leading spur from Korada, passing over limestone and lava at intervals. The limestones unconformably overlaid the volcanic rocks.

From Tauputa I skirted the coast to the north-west as far as Agonai. There was practically no beach, for the land plunged down suddenly into deep water. The coast in this neighbourhood is practically timberless, and the bold cliffs afford splendid opportunities of studying the geology. I could see from the boat several conspicuous limestone escarpments at all altitudes above the sea-level.

When nearing Agonai we entered a small fresh-water creek, from a cliff on the bank of which I obtained specimens [35] of a weathered dolerite. Our whaleboat was overtaken by the steamer at this point, and we passed Girumia (Cape Frere). This bold headland "stands out so far from the general coast range that by crossing the low hilly and undulating ground on its landward side, one would pass from the head of the bay, north of Tauputa, into the south end of Goodenough Bay."†

The

* R. L. Jack and A. W. Clarke, Report on Geological Specimens. Ann. Rep. B. New Guinea, 1888-1889, Brisbane by Authority.

† Despatch 100, 1890, par 4.

The sides of Girumia are seamed by deep narrow glens, so that the mountain appears to be covered with long narrow ridges. These peculiar ridges are very common on the cones of the D'Entrecasteaux group. Girumia may be a partially denuded tuff or scoria cone.

As we entered Goodenough Bay I was able to see something of the peculiar terraced appearance of the most of the hills, described in the above-mentioned Despatch in the following terms:—"The southern end of Goodenough Bay is remarkable for a number of little plateaux of apparently quite level ground, some of them probably 700 or 800 feet above sea-level, formed by the washing down of *débris* from the glens above."*

On landing and following up a creek for about two miles, I came to the edge of one of these plateaux. The one I examined was composed of stratified gravel of volcanic *débris*, dipping at 5 to 10 degrees to the north. I was unable to satisfy myself as to whether these were volcanic ash, or some of those recent calcareous formations so prevalent in the Solomon Islands, and so well described by Guppy. Their peculiar terraced appearance strikes the observer as marking the sites of old shore lines, each terrace representing a pause in the elevatory process which the presence of elevated reef masses in the Tauputa district showed had been going on along the coast. That evidences are not wanting that upheaval has been going on round that coast of New Guinea, the following quotations show.

Baron N. De Miklouho-Maclay noticed proofs (raised coral reefs and greenish calcareous clays with remains of marine animals) of the rising in the Maclay coast of New Guinea, and he expressed the opinion that—"besides the occasional upheavals there exists a gradual steady rising of this part of the north-eastern coast of New Guinea."†

Darwin, quoting Lesson, records proofs of recent upheavals from the north coast of New Guinea, where, "near Port Dory, the shores are flanked to a height of 150 feet by madreporitic strata of a modern date."‡

Dr. Schneider mentions the occurrence of chalk (chalky limestone?) in the Snowy Mountains of Dutch New Guinea.§

On our way to Phillips Harbour the steamer anchored at Yasaiasa Bay, north-west of Cape Sebiribiri (Vogel). This cape consists of "a stretch of low hilly, wooded undulating country, from 20 to 25 miles broad."‖

Along the coast towards Phillips Harbour, cliffs of white coral limestone could be seen at intervals, while the distant hills had every appearance of stratified ash (?).

A description of the Expedition to Mount Suckling has been given by the Leader, the Hon. M. H. Moreton,¶ hence only the geological and geographical details need be mentioned here.

The Expedition started from Phillips Harbour, to the south of Collingwood Bay. It was not until Dori Creek was reached, on the sixth day after quitting the coast, that any rock was seen *in situ*.

About a mile and a-half above Camp 4, an andesitic agglomerate was met with in the bed and banks of the creek; further up, its place was taken by lavas of a similar type. The exposure is in a conspicuous cliff on the western bank of the watercourse. The cliff forms the termination of a low range of hills which have a dominating trend of north-west and south-east.

When at Camp 4, the Leader and myself penetrated a little distance to the west of the camp, and discovered a few square miles of open, well-grassed, timberless country, which appeared to rise gradually towards the low range of andesitic lavas mentioned above. The Sketch Map of Collingwood Bay, illustrating Mr. Moreton's Report, conveys a wrong impression of the position of the "low range," which should be placed about a mile and a-half above Camp 4, where Dori Creek skirts the foot of the range.

The bed of the creek above Camp 5 was full of large boulders of quartzite, schist, and a few of black graphitic schist, but no section was seen.

Camp 6 was formed on the left bank of a creek, which from its position appeared to flow into some other creek than that up which our route had previously led us.

Approaching the spur upon which Camp 7 was situated, our route lay for some distance over ground covered with boulders of Metamorphic Rocks, the *débris* from the Main Range. These were actually seen *in situ* in the vicinity of the camp. The rocks were greenish quartzite [60], and appeared to be lying almost horizontally. The dense vegetation prevented a very careful examination of the rocks being made. From this point until an altitude of 6,903 feet, at Camp 10, was attained, no other exposure of rock was visible *en route*. Here in the bed of a small tributary of Fir-tree Creek (?) were green chloritic schists [59]. The place of these was taken, at 7,700 feet, by a quartz schist [58], forming the inaccessible precipice which suddenly brought to an end our proposed journey to the summit of Mount Suckling. This precipice was appropriately named, by the Leader, Disappointment Rock; its mean altitude was found to be 7,718 feet above sea-level.

On the morning of 30th July, in company with the Hon. M. H. Moreton, I left Camp 10, and paid a second visit to Disappointment Rock, in order to take a round of angles and make a few outline sketches of the mountains. The sky was cloudless, and an uninterrupted view of the country on all sides was obtained.

Two conspicuous peaks, both devoid of trees, form the summit of Mount Suckling. The highest, which is not visible from the beach, bore 252 degrees 30 minutes, and was estimated by us to be distant about five miles. The summits were separated from us by a deep gorge, which appeared to be a tributary of Fir-tree Creek.

The spur upon which Disappointment Rock was situated joined another which ran almost at right angles to it, and led up to the main mountain mass of Mount Suckling. In part of the range facing us were one or two inaccessible precipices of some rock which weathered to a whitish colour. It is impossible to say of what they are composed. At a bearing 115 degrees was the lofty mass of Mount Dayman, separated

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* *Loc. Cit.* par. 4.

† Proc. Linn. Soc., N. S. Wales, vol. ix., pt. 4, 1885, pp. 966, 967.

‡ Coral Reefs, 3rd edition, p. 179.

§ Geologische Uebersicht ueber den holländischen ostindischen Archipel. Jahrb. der K. k. geologischen Reichsanstalt Wien Band XXVI., No. 2, 1876, p. 126.

‖ Despatch 100, 1890, par. 4.

¶ Despatch 58, 1891.

separated from Mount Suckling by a low divide. There are two summits; from one bearing 128 degrees 30 minutes "there extended towards us a sloping tract of almost timberless country, the surface of which appeared to be very rough." *

From our coign of vantage it was clearly seen that Mount Dayman was the remains of a large volcanic cone, which had been breached by an outburst of lava, flowing down towards the north-east coast. The rough, timberless country described by Mr. Moreton is the surface of this stream. Part of the crater-wall is still extant, and from our position we could look right into the crater. Some of the Cloudy Bay lavas may have originated from the Mount Dayman volcano. The sides of the mountain are covered with forest, and are drained by deep narrow gullies.

A curious feature with reference to Fir-tree Creek (?) is that the waters are seen to flow for miles through flat country along the foot of Mount Dayman, and to be suddenly deflected at right-angles by one of the spurs, probably a lava stream, and then to flow almost due north out to sea. The active volcano Mount Victoria bore of 352 degrees 30 minutes.

In the year 1890, the Administrator, in his inspection of the north-east coast of the Possession, viewed this mountain from Keppel Point, and gave an interesting description of it in the following terms:—"This mountain is very steep and rugged, presenting, towards the top, great masses of bare rock. Its altitude is probably from 3,500 to 4,000 feet. Its sides were scored and marked by brown lines from near the summit to its base; these at first looked as if caused by lava running down the mountain, but the closest inspection could detect no presence of lava, so that it was concluded that the lines had been caused by recent great earth-slips. Some of the fishermen occupied near the Sydney Islands spoke of a smart shock of earthquake that had been felt about three weeks before in Collingwood Bay, so well marked that one man was thrown off a camp-stool on the ground. A shock was felt on the mainland about the same time as far as Port Moresby. In all probability there is a close connection between these phenomena and the great earth-slips on Mount Victory. The summit of the mountain was not visible from near Keppel Point, on account of a dense cloud which rested on it, when the tops of Mount Suckling, 11,000 feet, and Mount Trafalgar, 4,000 feet, were quite unclouded. A column of steam could, however, be seen rising out of a ridge not far from the top of Mount Victory, and in a few days later we had an opportunity, in the early morning, of seeing numerous columns of steam rising, some from the very tops of the two crests of Mount Victory, others from spots a considerable distance from the highest points, issuing from crevices and hollows all round the two peaks. By 7 or 8 o'clock this steam always formed a dense cumulus over and about the top of the mountain, which looked like a thunder-cloud, and completely hid it from view.

"On Mount Victory vegetation is scant, a species of pine being the most conspicuous. Mount Trafalgar, on the contrary, is covered over the summit with dense forest. Flame was not at any time seen by us on Mount Victory, nor could we obtain from the natives any information regarding it."†

This district was visited by Captain Moresby and his officers, who, after rounding Cape Nelson before nightfall, on 5th April, 1874, "were much impressed by the fine picturesque appearance of Mounts Victory and Trafalgar." They do not appear to have noticed the emanation of either steam or smoke. At several places and at different times during our Mount Suckling journey, volumes of steam and smoke could be seen issuing from both the sides and summit of the mountain.

The Mount Victory mass was separated from the Main Range by a large area of flat, comparatively timberless, country.

The earth-slips described by the Administrator are probably the narrow gullies excavated out of a mass of fragmental volcanic material. Such gullies I found to be characteristic of those tuff cones which I examined in the D'Entrecasteaux Group.

From Disappointment Rock we were able to satisfy ourselves as to the non-existence of the Hornby Range, as shown on the charts. I made a series of observations for altitude, and a watch and compass traverse of the route. These have been published as Appendices to Mr. Moreton's Report.

The D'Entrecasteaux Islands.

My knowledge of the geology of the D'Entrecasteaux Group was obtained during a few days spent in the vicinity of Dawson Straits. It may not be out of place to give a *précis* of what is already known with reference to the geology of the group.

The first European to become personally acquainted with the islands of the D'Entrecasteaux Group appears to have been Captain Moresby, under whose direction their position was fixed, and a portion of the coast-line laid down, in 1874. The eastern side of the group was seen at a distance by D'Entrecasteaux, after whom it was named, in the year 1793, when on a voyage in search of La Pérouse.

Captain Moresby noticed, on the north shore of Moratau (Fergusson) Island, the absence of coral rocks, but noted the prevalence of black volcanic sand on the beach and sea bottom.‡

In the vicinity of Cape La Billardière, in the north of Moratau, the Basilisk's party discovered some boiling mineral springs, in the sand and mud thrown out by which "very small specimens of rubies (?) and amethysts" (?) were said to have been discovered.§

[Is it not possible that these rubies may have been garnets or zircons? Garnets are known to exist in the schists of the Duau. Schists are also prevalent in Moratau. The mud might be merely old alluvial deposits cast up by the springs; hence it would not be improbable to find any of the contained minerals redeposited on the surface.]

In the Annual Report on British New Guinea for 1888-1889, the Administrator refers to Captain Moresby's discoveries in the following terms:—

"Search was made by one party at that part of the island called Cape La Billardière for the hot springs marked on the Admiralty charts, but they could not be found. Some of those in search said, however, that they found what appeared to be traces of their previous existence. Some years ago Mr. Andrew Goldie visited this part of the coast, and found some hot springs in activity; but in the absence of

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* Hon. M. H. Moreton, "Report on Expedition to Mount Suckling." Despatch 58, 1891.
† Despatch 100, 1890, par. 13.
‡ Moresby, "Discoveries in New Guinea," p. 254.
§ *Loc. cit.* p. 255.

of the chart of his route their exact locality cannot at present be specified. It was found by us, however, that the whole of the low country near Seymour Bay contains, here and there, over an area of, perhaps, eight or ten square miles, boiling springs, saline lakes, and thousands of fumeroles giving out sulphur fumes."

Mr. Basil H. Thomson, in an account of his trip in this district, says that there existed also "springs of boiling water and boiling mud, and in one instance boiling mud was spouted up from a chimney-like cavity in the hill side."*

Four samples of water from these springs were collected and submitted to Professor Liversidge of the University of Sydney, for analysis, from whose Report the following may be quoted:—

"None of the specimens were in sufficient quantity to permit of a full analysis being made of their mineral constituents, the largest being in a so-called quart bottle. The only quantitative determinations which could be conveniently made were the total solids, fixed solids, loss on ignition, and chlorine. The loss on ignition includes any organic matter which may have been present, the loss of water of combination, volatile and decomposable salts, together with some sulphur."

The Analyses, in parts per 1,000, are as follows:—

	1.	2.	3.	4.
Loss on ignition	9·63	1·274	·630	2·110
Fixed solids	4·47	3·630	2·470	5·470
Total solids	14·10	4·904	3·100	7·580
Chlorine	...	1·240	·730	1·390

1. "Seymour Bay, Fergusson Island, 11-11-88. Boiling water from hot springs.
2. "Hot Springs, Seymour Bay, 11-11-88. Water after boiling.
3. "Seymour Bay, 11-11-88. Boiling water from small spring.
4. "Seymour Bay, 11-11-88. Water from lagoon, hot springs saline lake. Margin surrounded by sulphur."

The solid matter in sample 1 "was found to contain a few diatom frustules and small crystals of selenite (calcium sulphate), and a good deal of sulphur."†

The presence of Metamorphic Rocks, penetrated by dolerite, and the prevalence of basic lavas, were demonstrated by an examination of a suite of specimens from the D'Entrecasteaux Group, reported on by Mr. R. L. Jack in 1889. Some of the Volcanic Rocks have been described by Mr. A. W. Clarke, in an Appendix to Mr. Jack's Notes, and also in "Petrographical Notes on Specimens from Queensland and the Adjacent Colonies."‡ This comprises all that was known of the geology of this interesting group, and my visit did not bring any new facts to light.

I landed on the south-west coast of Duau (Normanby) Island, in the neighbourhood of Koruwea (Perry Bay of the charts), and made a traverse of a creek—Sebuseburu (?). The first rocks seen *in situ* were micaceous quartz schists [54], dipping at angles varying from 30 to 40 degrees to the south-south-west. A little further up, these beds contain lenticular masses of quartz, with small quantities of mica. These lenticules are parallel to the bedding-planes. Here the schists are pierced by a dyke of dolerite, one foot in thickness. These were succeeded by dark-green garnetiferous hornblende schists [55], which appeared to be vertical. The schists contain nodules of iron pyrites.

Further up, the hornblendic schists contain large quantities of iron pyrites in lieu of garnets [56]. An exactly similar section was seen in a creek (the name of which I could not ascertain) rising in the Soromonai Hills and entering the sea somewhere between Etrara and Noruia.

Whilst I was engaged on the island, the Administrator followed the coast-line for several miles, into Dawson Straits, and brought back specimens which enabled me to ascertain that the small island of Guretabuabu was of granitic gneiss.

During the stay of the "Merrie England" off the island of Dobu (Goulvain) I had opportunities of investigating the structure of the island, and also of a portion of the south end of the Moratau (Fergusson) Island.

The Island of Dobu was visited, in 1888, by the Administrator, who described it as being "from four to five square miles in area." Mention was also made of "an extinct crater, one side of which is still intact."

Approaching Dobu from Dawson Straits, it appeared to have all the characteristics of a volcano. Steam could be seen issuing from points on the beach on the north side of the island. On Moratau (Fergusson) Island, near Ebeoa (Llewellyn) Point, another volcanic mountain identical with that of Goulvain, could be seen. Viewed from the anchorage off Boduwagui Point, the highest summit of Dobu was seen to be a truncated cone, having an almost flat top, with numerous spurs running down to the beach. The seaward face is deeply furrowed by wooded ravines. On landing near the site of the new Wesleyan Mission Station, I, accompanied by Mr. R. E. Guise, the Naturalist, walked along the coast to the northward as far as the points from which steam was seen issuing. The cliff sections showed nothing but brownish stratified sand and gravel, containing sub-angular pebbles of some glassy volcanic rock, and pumice. Some of the gravel is solidified into sandstone. It is through this sandstone that the so-called "springs" issue, below the high-water mark.

My first visit was paid at about the time of high water. There were several orifices, from which water issued at an average temperature of 200 degrees Fahrenheit. I estimated the area over which the waters issued at about 100 square yards. The gas, given out copiously, had a strong sulphurous odour. The sandstones in the neighbourhood were slightly bleached.

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* Basil H. Thomson, "Narative of an Exploring Expedition to the Louisiade and D'Entrecasteaux Islands," Proc. Roy. Geogr. Soc. London, Vol. XI, No. 9, 1889, p. 539.

† Prof. A. Liversidge, "Notes on some Hot Spring Waters," Austr. Assoc. Adv. Sci., Vol. II., pp. 388, *et seq.*

‡ About to be issued with Messrs Jack and Etheridge's work on the Geology and Palæontology of Queensland and New Guinea.

A second visit to the locality at low water showed that the so-called "boiling springs" were merely fissures to which sea-water had access. The sides of the fissures were encrusted with deposits of flowers of sulphur. A few yards behind the fumeroles was a whitish-grey cliff, exhibiting undoubted evidences of solfataric action.

The material of which the cliff is formed is of a white colour, and has the following composition:—Silica, 87·16; Alumina, 2·2; Iron Protoxide, 2·66; Soda and Potash, 0·21; Manganese, a trace; Lime, a trace; loss on ignition, 7·87 per cent.

In caverns in the cliffs there occur large deposits of yellow and greyish-brown sulphur, commonly massive, but here and there in the form of acicular crystals. These caverns, many of which I discovered when breaking down the cliffs with my hammer, were found to have a very high temperature. In one case a stream of hot air rushed out with a hissing noise, but this was only momentary.

Along the west coast of Dobu, cliffs of stratified gravel prevail, while on the east the stratified material of the cliffs was partially consolidated into rock. The beach was strewn with a large quantity of pumice [45].*

Near the centre of the south-east end of the island is an extinct crater; what remains of it now is a lofty almost circular wall, roughly estimated at about 100 feet in height. A lava stream, rising in the crater, has eaten its way through the wall, and enters the sea opposite the island of Nekumara (Epidermis). I walked along the crater wall (upon which a few villages have been built) for some distance.

To the south of this there is another similar crater, with a small lagoon within. I ascended the summit of the highest point of Dobu, and found it to be 920 feet, by Aneroid, above the base. The summit of the cone had a slight depression, which sloped away gradually to the lip or the crater on the north-east.

During my hasty examination of a portion of this island, no lavas *in situ* came under my observation.

Upon the island of Nekumara (Epidermis), which I had no opportunity of critically examining, I am informed on reliable authority there exists a hot spring. The soil is said to be partly of volcanic origin.

From Dobu I examined, in company with the Administrator, the coast line of Moratau from Ebeoa (Llewellyn) Point to Girigiria.

Crossing the bay in a whaleboat in tow of the steam launch, the crateriform shape of Diau could be easily seen. Steam could also be seen rising at several points on the land to the north.

Our first landing place was on the beach, protected by a shore reef, between the two points—Atawaina and Rawia. The bold headland, Atawaina, was of a finely-banded stony lava [41 and 42], in which small sanidine crystals could be seen by the aid of a lens. I was unable to make any satisfactory observations of dip, but so far as could be made out in the short time at my disposal, the lavas appeared to have a low inclination to the seaward—*i.e.*, south-south-east. The grassy, timberless hill, which slopes gradually down to the sea at Rawia, is formed of similar rocks to that of Atawaina, and represents the surface of a lava flow.

After procuring a fresh supply of water for the launch at Nekumara, we entered the small bay surrounded by a crescent-shaped wall to the north-west of Rawai Point. Its peculiar scythe-shaped form pointed to its being the segment of an ancient crater, and an actual examination confirmed this view. Manifestations of solfataric action were evident on the face of the cliff.

Our party landed on a coral reef which fringed the foot of the cliffs. In places the sea water was quite hot, owing to the streams of hot water which flowed down from the hills behind.

I ascended the crater-wall to the spot from which water vapour could be seen issuing in a long straight column. Andesitic lavas prevailed. The one main vent—there were several minor ones—from which steam and gas, with a strong sulphurous odour, were emitted, was surrounded by a large area of red and yellow clay, resulting from the decomposition of the lavas. There were all gradations. At one end of the series was a perfectly unaltered lava (to the unaided eye) passing gradually into pure clay. One specimen [40], partially altered, was a semi-vitreous and somewhat cellular lava, in which sanidine could be seen. From several points on the face of the cliff copious streams of hot water were given out.

The morning subsequent to my visit to this place I chartered a catamaran and landed at a village in a little bay south-east of Diau. Having procured guides, I ascended the top of the crater, the highest point of which rose to 900 feet above the beach. The ascent was made up a gully carved out of a blackish ash, with fragments of pumice and a glassy volcanic rock. From the summit an excellent view of the cone and it associations could be obtained. This is a tuff cone; its south-eastern face is hollowed out into numerous ravines, in which occasional sections show stratified ashes.

The crater-wall has been breached by a lava which has flowed to within a short distance of the beach near Worua Island. The lava has a surface overgrown with long grass of indescribable roughness, rendering locomotion on its surface somewhat precarious. I followed the edge of the lava flow from its source to its termination, and was enabled to ascertain that its general character is similar throughout. The rock [43]† has a glassy, resinous lustre and a splintery fracture. Weathered surfaces show undoubted fluxion-structure, the lines of flow sweeping round the sanidine crystals, sanidine being the only mineral visible to the eye.

Specimens [51] brought back by Sir William Macgregor from the coast of Moratau showed that the lower flanks, at any rate, of Edagwaba Mountain were of a similar geological nature to that of the north end of Duau.

From the summit of the crater the emanation of water vapour could be seen over a large area of country to the north.

* Analysis of No. 45:—Silica, 69·62; Alumina, 15·26; Iron Protoxide, 3·05; Manganese, a trace; Lime, 0·94; Potash, 5·20; Soda, 2·36; loss on ignition, 3·69.

† Analysis of No. 43:—Silica, 71·27; Alumina, 9·10; Iron Protoxide, 10·13; Manganese, a trace; Lime, 0·89; Potash, 3·14; Soda, 5·18; loss on ignition, 0·25.

The Louisiade Archipelago and neighbouring Islands.

Louis Vaez de Torres is credited with being the discoverer of the Louisiade Archipelago, in August, 1606.

The geology was first described by Macgillivray, who sets it forth that "such of the islands as were examined consisted of mica slate, the line of direction of the beds of which is nearly the same as that of the Archipelago itself; and the physical appearance of the other islands leads me to believe that the same rock prevails there also.*

Remark is also made of "the total absence of signs of volcanic agency" in the Archipelago. The sequel shows that remains of craters and volcanic rocks do exist in some of the islands of the group, which, however, were not examined by Macgillivray.

Dana states that "all the conditions from fringing to barrier and from the barrier island to the atoll are admirably illustrated in the Louisiade Archipelago. The small amount of included high land within the enormous barrier, the linear form of the high islands, and the many islets which continue the line westward, the appendage-like relation to the large barrier-island of the islands at its north-east and north-west ends, look as if all the pieces of high land were parts of a nine-tenths-buried mountain-chain; and so much like it that any other supposition is evidently unreasonable."†

Leaving Samarai on June 26th, *en route* for the Louisiades, our course was generally south-east. We passed between the Lebrun Islands and the Bell Rock, and anchored for a while off the north coast of Ware (Testo) Island.

When approached from the north-west, Bell Rock, as its name implies, presents the appearance of a gigantic bell. The islet, the altitude of which, as given by the Admiralty chart, is 420 feet, rises abruptly from water from 16 to 30 fathoms in depth. The cliffs are perpendicular, and those on the north appeared to be quite inaccessible. A cocoanut tree could be seen growing near the summit. Bell Rock is composed of a yellowish and white bedded rock, dipping at a low angle to the north, which, when viewed through a pair of good binoculars, appeared to be fragmental, the mode of weathering suggesting a calcareous origin.

A low elongated rock—Cliffy Island—was of a similar nature.

In the short time that the steamer remained at anchor off the north-west end of Ware, I was not able to do more than to ascertain that the beach was strewn with blocks of olivine basalt [83]. An escarpment at the beach was composed of a hard cream-coloured sonorous coral limestone, underlaid by a leaden-grey calcareous breccia containing fragments of olivine.

Dr. Guppy describes the occurrence, in one of the smaller islands of the Solomon Group, of a raised coral reef, "based on volcanic rock, with the intervention of a thin brecciated conglomerate."‡

Skirting the north coast of Testo Island, the cliffs forming the coast appeared to be of coral limestone also. A marked peculiarity was the disposal of these beds (when viewed as a whole) into a series of gentle folds, the axes of which trended roughly north and south.

Leaving this interesting island, we anchored in the Bagavirana (Conflict) Group for the night. Soon after the anchor dropped, I landed for a short time on one of the islands, which is raised but little above the sea-level. The beach is strewn with corals and pumice drift.

The group is thus described by the Administrator:—"The group forms an atoll about half a score of miles from east to west, and about half as much from north to south. There is deep water inside generally, but so far as one could see there are only two channels by which a large vessel can enter or leave, one on the south-east side, the other on the north-west. There are altogether about a score of islands, the total area of which is probably between four and five square miles. They are not now, and, judging from the almost phenomenal complete absence of cocoanut trees, apparently never have been, inhabited. It appears that fresh water is obtainable on two, if not on three, of the islands. They are raised from about one to three yards above high water-mark. They are covered by wood, the most common tree being a *Casuarina*, which here reaches a comparatively large size, many trees being three feet or more in diameter. The soil consists of coral sand and a certain amount of decayed and decaying vegetable matter."§

On the following morning, we steamed slowly through the group, following the track taken by H.M.S. "Conflict" in 1880. From Bagavirana we headed for the Pannaet (Deboyne) Islands, passing, to the north-west, a group of nameless "low and thickly wooded" islands (latitude 10 degrees 45 minutes; longitude 152 degrees 5 minutes) and the "uninhabited group of the Bonabonana (Torlesse) Islands, some eight or ten miles from Pannaet."

The "Merrie England" dropped anchor in a channel between the reef (west of Panapompom) which encircles the Deboyne Group. Shortly afterwards I landed on the south coast, and had an opportunity of examining a portion of the coast-line. Approaching the island, from our anchorage, in a whaleboat, we had to pull over a tract of very shallow water about a mile in width. A considerable portion of this shore platform appears to be laid bare at low water. The seaward face plunges down rapidly into very deep water.

The first feature that attracts the attention of the geologist on landing is a conspicuous white perpendicular cliff, from seven to ten feet in height, continuous along the whole length of the beach. The cliff is composed of a white coral limestone [68], which weathers into curious cavernous forms. The limestone contains fragments of coral and shells. In one piece I detected a Brachiopod, which I have been unable to name. The summit of the cliff forms a low tableland of considerable extent, upon which the natives have erected their houses and gardens.

From the interior of the island, which I had no opportunity of visiting, rises a conspicuous mountain, given in the charts as being about 1,500 feet in altitude.

From the occurrence, on the beach, of pebbles of basic crystalline schist (which the gestures of the natives informed me came from the interior) Pannaet may be composed of schistose rocks.

The neighbouring island of Panapompom (Ware) is described as being "on the whole, a hilly island, having an altitude of 500 to 600 feet at some points, densely wooded, but apparently fertile, and about four square miles in area."‖ I examined a section in a dry creek, near the north coast of the island,

* Macgillivray, "Voyage of H.M.S. 'Rattlesnake,'" London, 1852, vol. ii, p. 71.
† Dana, "Coral and Coral Islands," 3rd edition, p. 269.
‡ H. B. Guppy, "Geology of the Solomon Islands," 1887, p. 71.
§ Despatch 97, 1890, par. 7.
‖ Despatch 49, 1891, par. 4.

island, and saw nothing but dark basic crystalline schists [57], similar to those of Duau, dipping at a low angle to the south-east. On the hill slopes the soil turned up for gardening by the natives was found to be full of pebbles of these schists. I learned from one of my native guides, who spoke intelligible English, that a party of prospectors had visited Panapompom, but with what result I could not ascertain.

From the Deboyne Group the steamer conveyed the party to some of the islands of the Calvados Chain, in the Louisiade Archipelago. It will be more convenient, however, to describe next the geology of Kimuta (the largest of the Renard Islands), and the island of Misima (Saint Aignan), leaving the description of the Louisiades proper until later.

Kimuta, a well-grassed island, the largest of the Renards, is marked on the Admiralty chart as being about 500 feet in height. On landing I was able to examine the section seen in the cliffs along the coast. Sections show vertical slates, with an easterly strike, interbedded with coarse conglomerate, containing pebbles of quartz and slate. Dykes of dolerite penetrate these sedimentary beds. Veins of quartz and calcite traverse the dolerites. In one place the dolerite is pierced by a reef of quartz twelve inches in thickness, striking north 75 degrees east. It yielded no trace of gold.

A conspicuous cliff (Mguoa?), forming the west end of the island, is composed of a cream-coloured coral limestone [69], seamed with veinlets of carbonate of lime. This limestone, a portion of a raised coral reef, contains fragments of coral and shells.

From the anchorage of the "Merrie England," off Bagoya, where the quarters of the Resident Magistrate of the Louisiade Group are situated, I was guided to Gumonina (Inkomanina) Creek, in which a few men were engaged in working for alluvial gold.

Gumonina Creek flows in a general southerly direction, and enters the sea on the south coast, somewhere between the villages of Gaibobo and Labbipi. A little over two miles above the mouth of the creek, clay slates can be seen in the banks to dip at high angles to the east. Further up, the creek flows through a narrow gorge, with steep walls of schistose rocks. In the bed of the creek, quartzose graphitic schists [53] are exposed. The beds are vertical, and strike east and west (parallel to the length of the island), and contain numerous quartz veinlets. The schists are penetrated by a pale grey granite [49] containing colourless mica. The boulders in the bed of Gumonina Creek were for the most part of schist, but there were also a few of coral limestone in the upper portions.

Subsequently I had an opportunity of examining the coast-line in the vicinity of the mouth of Gumonina Creek. Here the coast consists of an almost flat terrace, a little above the high-water mark, of white or cream-coloured limestone, the seaward face of which plunges suddenly down into very deep water. From this rises a white vertical escarpment, of about twenty to thirty feet in height, forming another similar terrace. The face of this cliff is weathered into curious cavernous forms. Through this mass of upraised coral reef Gumonina Creek has cut a channel for itself to the sea. A generalised section up Gumonina Creek is shown in Fig. III., Plate III.

The whole of the coast-line, as far as Tenoklamana, was fringed with similar coral limestones, in the form of level terraces with vertical walls. These were observable at all elevations above the sea-level.

Viewed from the deck of the steamer at a distance, nearly the whole of the south coast of Misima was seen to be formed of a series of level terraces at all elevations.

I had no further opportunity of examining the elevated reef-masses of the south coast than was afforded by a traverse along the coast from a point near the village of Lagira to Bagoya. The character of the rock was the same throughout. No organic remains were noticed. The structure of the corals appeared to have been entirely obliterated.

Along the upper surface of these terraces, "swallow holes" and fissures of unknown depth were common. Above the level of the lowest terrace vegetation had taken root.

Along the north-east coast in the vicinity of Treachery Bay of the Admiralty charts, interesting sections are seen showing the relation which the elevated reef-masses bear to the underlying rocks.

From Sagara I traversed the coast as far as Gulewa Creek, in company with two English-speaking natives and several others. For some distance the track skirted the foot of vertical cliffs of white limestone identical with those of Eihaus. When approaching Gulewa, bold cliffs of coarse volcanic conglomerate, full of pebbles of an acidic lava, are encountered. Interstratified with these were thin lavas of a trachytic type [46,* 47, 48]. These volcanic rocks were covered by the coral limestone.

From Gulewa I waded up the creek (in the bed of which schist and limestone pebbles were conspicuous), until a large vertical wall of limestone was encountered. By Aneroid the altitude was 100 feet above the sea. From beneath this escarpment of limestone, the waters of Gulewa Creek issued with a loud noise. I scaled the cliff and found myself on a "dip slope" of limestone full of gigantic swallow-holes. At intervals in the cliffs could be seen the entrances to caverns (yet unexplored), from the roofs of which were hung pendant-like masses of carbonate of lime.

Eventually my guides led me to the edge of a gigantic swallow-hole, at the bottom of which water could be heard flowing. A precarious scramble down the face of the cliff, showing coral limestone resting on coarse volcanic conglomerate, brought us to the bottom of the hole, at 220 feet above the sea-level. Here the waters of Gulewa Creek emerged from beneath a cliff of ash capped with limestone, entered a cavern eighty or ninety feet in height, and disappeared with a deafening roar. The cavern, about an acre in area, is full of both stalactites and stalagmites, presenting a very picturesque effect. The stalagmites rest upon a foundation of sand. The bed of the creek is full of schist pebbles, showing the underlying rock to be of that nature. The limestone forming the Gulewa cave [66] contains corals, the structure of which has not been entirely obliterated.

I was unable to ascertain whether the cave described by Mr. Basil H. Thomson was the one I visited. Mr. Thomson says:—"The limestone hills which compose the centre of the island are honeycombed with caves. Near a spot called by the natives Kaiaba, a stream, after taking its rise from a great wall of limestone, plunged into a great cavern in the opposite cliff. The mouth was a perfect arch, 150 feet from floor to roof. At the far end the river thundered down into a black tunnel, through which it passed under the range, emerging into daylight after some three miles of darkness.† Such limestone caverns are common in the other areas of upraised reefs—viz., the Solomon Islands, the Tonga Islands, &c.

Utian

* Analysis of No. 46:—Silica, 68·02; alumina, 14·08; iron protoxide, 0·29; iron peroxide, 5·19; manganese, a trace; lime, 5·30; potash, 1·26; soda, 5·17; loss on ignition, 1·37.

† "Narrative of an Exploring Expedition to the Louisiade and D'Entrecasteaux Islands."

Utian (Brooker) Island is described as lying "inside a large lagoon to which there is only a boat passage," and, "about two square miles in area . . . . hilly and wooded, with an altitude of 400 to 500 feet." *

After a long pull over from the anchorage of the steamer on the north of Moturina (Mewstone) Island, I landed one morning in the eastern bay of Utian, and examined such of the coast as was accessible.

Sections along the coast showed nothing but lavas and consolidated ashes dipping at low angles to the eastward. The lavas [37] agreed in their general characteristics, in consisting of felspar (sanidine ?) and some ferro-magnesian constituent embedded in a dark-coloured stony matrix. The ashes vary very much in grain. The coarser varieties contain large fragments of lava. The finer-grained ashes [38] are of a buff colour.

Returning to our whaleboat, as we skirted the south-west coast of Utian, I was able to see that bedded rocks occupied the cliffs. The weathered surfaces presented a similar appearance to those of the eastern bay.

From specimens brought to me by a member of the party that visited the neighbouring islands of Panaudiudi, coarse volcanic conglomerate appeared to prevail.

In company with Captain Hennessy, I was able to pay a very hurried visit to the bold rocky island of Panarora (Eddystone). From base to summit (540 feet), the bare cliffs showed nothing but a coarse volcanic conglomerate. This at one spot gave a dip measurement of about 30 degrees to the south-west. The pebbles [39], of which the conglomerate was composed, appeared to be of a similar nature to the Utian lavas, but of a finer grain.

To the west of the Village of Marora there is a large area of "beach sand-rock." This has a low dip to the seaward.

From Panaroro, while the steamer was at anchor in a sheltered bay on the north side of Moturina (Mewstone) Island, I was enabled, in company with Mr. Phillips, the Chief Engineer, to examine the structure of the coast. I found that platy fissile limestones formed the cliff to the east of the ship's anchorage. The individual beds varied very much, some being more massive than others. The limestones, which are of a greyish colour, yielded no fossils. There were many minor foldings in the beds, but they were, on the whole, disposed with a low dip to the north-west. In places the rocks were penetrated by dykes of a greyish syenitic rock [36], and minor veins of a rock similar to that penetrating the dolerite of Samarai [29, 30]. In many of the minute bays a breccia of limestone pebbles in a calcareous matrix was seen to be forming. From another portion of the island, which I was unable to visit, Mr. Moreton supplied me with specimens of graphitic schist [80], somewhat similar to that of Misima. To the westward these sedimentary beds are covered by coarse volcanic conglomerate, similar to that of Panaroro. These dip at a low angle to the west. Similar rocks appear to form the higher summits of the island.

The cliffs of the neighbouring islands of Venariwa and Ululina, as viewed through a binocular, appeared to be of a volcanic nature also.

Steaming along the south of the Calvados Chain, *en route* for Tagula (Sudest) Island, cliff sections in several of the islands showed that bedded rocks, with a westerly dip, prevailed.

From Panumum Island Mr. Moreton, who was at that time Resident Magistrate, procured some rock specimens, which have been presented to the Museum of the Queensland Geological Survey. The specimens demonstrate the presence of talc schist [79] on that island.

An excellent view of Panasia (Real) Island and Panavarara (Rugged) Island, was obtained from the deck of the "Merrie England." These islands were surrounded by bold, apparently vertical cliffs, rising abruptly from the sea. The cliffs were composed of a yellowish-coloured rock, in all probability a limestone. Viewed from the distance, the larger of the two, Panasia, showed many points of resemblance to the drawing of the elevated coral island of Metia or Aurora, which has done duty in many geological manuals.

My first acquaintance with the Island of Tagula (Sudest) was made at the north-west end. I landed at a spot between Brady and Lory Points of the charts, and spent a whole day in the examination of a district at which a couple of miners were engaged in working a reefing claim. This part of the island is thus described—"From end to end of the island, which runs in a general north-westerly direction, there is a chain of hills, the highest point of which is Mount Rattlesnake, about 2,700 feet in altitude. This chain, as it nears the north-west end of the island, attains heights of from 800 to 1,000 feet. At the south corner there it runs up close to the sea; at the north corner it stops short about a mile or a mile and a-half from the shore, sloping down fast into grassy plateau devoid of trees. This again is fringed by a belt of mangrove. It is near the south end of the grassy plateau, about half-way between the hills and the sea, and about 150 feet above the latter, that the miners are at work."†

In the vicinity of the workings, which are described on a later page, the rocks have a general north-west and south-east strike, and are vertical. These rocks consisted of clayey talc-schist [61], some varieties being much more quartzose than others [62]. They bear the same general characteristics throughout, and are exposed in the beds and banks of almost all the creeks, and occasionally in the hill sides.

In the vicinity of Beu (Bousquet) Point, near Viku Hill, clayey slates were exposed. Ujuji Hill is composed of clay slates, which dip north at about 40 degrees. In Dumaga Bay, near Cape Baganowa (Condé Point), the slates dip at angles varying from 30 to 40 degrees to the north-east.

Of the geology of the north coast I have no personal knowledge, but Mr. John Macgillivray made a traverse up what is marked in the charts as Watering Creek, near Nepenthes Point. The further progress of the party in boats was stopped by "a ridge of rocks stretching across from side to side, marking the limits of the tidal influence."‡ It is further stated that "the rock is scarcely ever exposed in the banks of the river, except at the rapid before alluded to. Though still mica slate, it is there of much greater hardness and denser texture than in Pig and Round Islands, and stretches across the stream like a dyke, running nearly north and south, with a westerly dip of about 60 degrees. Elsewhere, along the shores of Coral Haven, this mica slate is of a leaden hue and glistening lustre, yielding to the nail with a slight greasy feel, especially in some pieces of a shining ash-grey acted upon by salt water. From hand specimens alone it is difficult to assign a name to this rock, as it partakes more or less of the character of mica, chlorite, and talc-schists." Briefly

* Despatch 49, 1891, par. 5.
† Despatch 2, 1891, par. 2.
‡ Voyage of the H.M.S. "Rattlesnake," vol. i, p 209.

Brierly Island is stated by the same authority to be of mica slate.

That the geology of Pig Island in Coral Haven is similar to that of Tagula (Sudest) Island is evident from the following description :—

"The rock on Pig Island, when exposed at some of the points, is mica slate, soft and splintery in many places, with frequent veins of quartz. The hills, although often running in ridges, have a rounded outline, and the soil on the smooth grassy places—comprising three-fourths of the island—is composed of disintegrated rock mixed with pieces of undecomposed quartz, any considerable accumulation of vegetable mould being probably prevented by the heavy rains."*

Round Island is also similar in constitution. It is described as being of "mica slate, varying much in texture and composition, often highly ferruginous; the strata run east-south-east and west-north-west, with a northerly dip of about 45 degrees."†

Of Rossel Island, I have no personal knowledge, but an examination of two suites of specimens presented to the Survey Collection has enabled me to ascertain something of the nature of the rocks occurring there. Beyond the mere fact that the specimens were obtained from Rossel Island, no details as to the exact locality from which the specimens came were supplied. The collection demonstrates the presence of talc-schists [90] (similar to those of Tagula and some other islands of the group), indurated black and grey shales [89, 91], and dolerites (?) [92].

ECONOMIC GEOLOGY.

The list of minerals of economic importance hitherto met with in British New Guinea is extremely small. Considering, however, the enormous area of country yet quite unknown, and the comparatively small number of persons who have hitherto made the search for minerals the object of their visit to New Guinea, and the fact that the natives of the country do not make use of the more important minerals, this scarcity need excite no surprise.

I have endeavoured, in addition to describing what came under my own observation, to collect together any information regarding the mineral deposits of the country, so as to produce a record of the economically useful minerals in the Possession up to date. To have given a bare list of minerals without any further details would have been useless. From the published matter with reference to the occurrence of the minerals only such as is useful and important has been extracted.

As to the portions of British New Guinea where the search for minerals of economic value may be prosecuted, the evidence is much more meagre than could be desired. To map out the possibly metalliferous areas with any approach to accuracy would entail many months of arduous labour in the field. The work I did was merely a flying reconnaissance of a very rapid kind, but I gained a fair notion of the structure of the country, and was able to deduce the following considerations :—

With a few trifling exceptions mentioned in the preceding pages, the whole of the coast line of British New Guinea is bordered by a selvage of comparatively recent volcanic rocks and elevated coral reef masses. These have effectually concealed the older underlying rocks (the matrices of the metalliferous minerals). Unless where denudation has succeeded in laying bare these older rocks, it is almost hopeless to expect that prospecting can be carried on with much chance of success. The underlying rocks are *known* to be exposed in the Vanapa, the Laloki, and the Kemp Welch, in the deep gorges on the northern flanks of Mount Suckling, and in many of the islands adjacent to New Guinea. Until the country has been properly geologically examined, the possibly metalliferous areas can be no further delineated than has already been done. It must be candidly admitted that, so far, except in the islands, no very promising indications have yet been discovered.

On the adjacent islands, chiefly on Misima (Saint Aignan) and Tagula (Sudest), a fair quantity of gold has been obtained, mainly, however, from alluvial deposits. On Misima the deposits are remarkable for their thickness, which is mainly accounted for, however, by the very large quantity of partially consolidated volcanic ash, which lends itself easily to denuding agencies. From what was seen on this island, there appear to be alluvial deposits enough to attract the attention of diggers for some time to come. Many difficulties, almost unknown in Queensland, have, however, to be encountered in New Guinea, rendering prospecting, unless with properly equipped and well organised parties, almost impossible.

GOLD.

The earliest record of the discovery of gold in British New Guinea to which I have access is that contained in a letter sent to the *Times* newspaper by Captain Moresby, on his return to England from a surveying cruise in H.M.S. "Basilisk." This letter, republished as an Appendix to Captain Moresby's Work, "Discoveries and Surveys in New Guinea," bears no date, but was probably written in the year 1876. Beyond the bare statement that some of the "Basilisk's" company found "auriferous quartz in Fairfax Harbour, Port Moresby," no details are given.

Mr. A. C. Locke, referring in 1882 to the discovery in Fairfax Harbour, says that some of the crew of the "Basilisk" picked up a piece of auriferous quartz from the bed of a stream in Moresby Island, flowing into Pitt Bay, "but a second could not be found."‡

The year after Captain Moresby's letter was made public, it was announced that gold had been discovered by the Rev. W. G. Lawes, of the New Guinea Mission, on the Laloki River, at no very great distance from Port Moresby, and by a party working under the direction of the late Mr. Andrew Goldie (a well known trader and collector), on a tributary of the Laloki, which now bears his name. The specimens passed through the hands of the late Mr. C. S. Wilkinson, Government Geologist of New South Wales, and a description of them was embodied in a Report presented by him to the Department of Mines of that Colony. The announcement of the discovery by Messrs. Lawes and Goldie, Mr. Wilkinson stated, was a confirmation of the conclusion to which he had arrived from "an examination of the rock specimens already obtained from New Guinea by the Hon. W. Macleay, M.L.C., during his voyage of exploration in the 'Chevert,' and by Mr. D'Albertis on the Fly River." Mr. Wilkinson, however, stated that the prediction of the possibility of auriferous deposits occurring in the colony was not made public from humane motives. The

* *Loc. cit.*, vol. i, pp. 188, 189.

† *Loc. cit.*, vol. i., p. 200.

‡ Gold: Its Occurrence and Extraction, A. C. Locke. London: Spon and Sons, 1882, p. 479.

The first party organised for purely prospecting purposes was that which left Australia in the spring of the year 1878 in the "Colonist." The members of this party examined the country drained by the Laloki and the Goldie, but do not appear to have met with any very encouraging results, for it is stated that "the total distance traversed by the party during their three prospecting trips was 370 miles, and throughout the whole of that distance not half a grain of gold was discovered."*

The late Mr. Richard Daintree, writing in February, 1870, upon the metamorphic rocks of Northern Queensland, and the occurrence of gold in New Guinea, remarks:—

"It would seem, therefore, that the rock formation of the three largest Northern diggings, the Peak Downs, and a portion of the Gilbert, is largely represented at the south-eastern extremity of New Guinea, with an authenticated trend or strike, which, if continuous, would give such rocks a large development in the interior, and so afford fair promise of goldfields when colonised."† ‡

TAGULA (SUDEST) ISLAND.

During my journey I had the opportunity of spending one day in an examination of the reefing district at the west end of Tagula (Sudest) Island, a member of the Louisiade Archipelago. As there was neither time for systematic work nor for prospecting, all that I could do was to make a rapid examination of such of the reefs as were open to inspection. The following notes embody the results of my work on the island:—

Caledonian Claim.

The only reefing claim at work in June, 1891, was the one held by Messrs. Maclean and Samuels, and named by them the Caledonian. The claim is situated about a mile and a-quarter from the sea coast, on fairly even, open, timberless country.

A series of specimens from the various leaders and reefs were collected under my direction, and a few were assayed for me by Messrs. Coane and Clarke, of Charters Towers. At the same time, I selected specimens which were crushed and washed in my presence by one of the holders, with fairly good results. Work was being carried on at the time of my visit by a vertical shaft, situated not far from the centre of the claim. The shaft was about 40 feet in depth, and from the shaft an underlie has been driven about thirty feet northwards. This, with the exception of the opening up of a few leaders, constitutes almost the whole of the work which has been done on the claim.

Several tons of quartz, from various parts of the claim, have been stacked ready for conveyance to Queensland for treatment. About three tons had been treated in Sydney, under the direction of Mr. S. S. Vale in December, 1890, and yielded 4 ozs. 18 dwts. of gold, and 1 oz. 21 grains of silver to the ton.

The following description of the various reefs and leaders on the ground held by Messrs. Maclean and Samuels will be best understood by reference to the appended Sketch Map, Plate I.:—

(*a*) This is a small leader of quartz about three inches in thickness, bearing east 10 degrees south. The quartz is milk-white in colour and somewhat cavernous. When broken some of the faces are seen to be coated with talc. A specimen crushed and washed by myself in Townsville did not give a prospect.

(*b*) Distant about thirty feet east from (*a*), and apparently on the same line of reef, a small trench, three or four feet in depth, exposes a thickness of fourteen inches of quartz. The footwall of the reef consists of (*b* 1) ten inches of quartz underlying at about 60 degrees to north 10 degrees east. This is separated from a rubbly quartz vein (*b* 2) of four inches in thickness by three inches of clayey shales seamed with minute veins of quartz. The quartz of the two veins does not differ in character. Both contain a fair percentage of iron pyrites. The four-inch vein carries in addition both hæmatite and limonite, sometimes as kernels and at others as botryoidal and stalactitic masses lining cavities in the quartz. A specimen from the larger vein yielded, on crushing and washing in Townsville, a very good prospect. Another specimen selected for assay showed only a trace of gold.

(*c*) The shaft, 40 feet in depth, has been timbered down to within a few feet of the bottom. In consequence of this nothing could be seen of the character of the reef from the surface downwards.

At the eastern end of the foot of the shaft five inches of quartz were seen to underlie at from 48 degrees to 50 degrees to north 15 degrees east. At the western end the reef had apparently died out. The quartz is of a white colour and contains a few kernels of psilomelane. Minute fissures or cracks are stained in places with oxide of manganese. There occurs also a small quantity of a greenish coloured mineral, one of the magnesian silicates. The small quantity in which this mineral occurs renders its determination a matter of some difficulty. It has every appearance of being serpentine.

A specimen collected by me from this place (*c* 1), when crushed and washed in my presence by one of the holders of the claim, gave a fair prospect, but an assay by Messrs. Coane and Clarke yielded only a trace of gold.

At a depth of thirty-four feet from the surface, an underlie has been driven for a distance of about 30 feet northward. Where the underlie joins the shaft there are two leaders of quartz separated by 10 inches of clayey shales. These leaders are each 1½ inches in thickness.

At a distance of eight feet down the underlie, and on its western side, the hanging-wall reef, which attains in the interval a thickness of three inches, underlies at 70 degrees to north 20 degrees east. The eastern side of the underlie shows six inches of quartz, which suddenly swells out into a bunch one foot thick. A drive to the east from the foot of the underlie shows six inches of quartz on the hanging-wall and an equal thickness on the footwall, separated by three and a-half inches of mullock (disintegrated clay shale). To the west the place of these is taken by a leader of quartz 1 inch thick.

Good prospects were obtained by crushing and washing in Townsville, samples collected by me from different portions of the underlie (*c* 2). An assay by Messrs. Coane and Clark gave 9 dwts. 17 grs. of gold and 1 oz. of silver to the ton.

(*d*) Is

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* Nature, vol. xix., 1878, p. 15.

† Daintree, R., General Report on the Northern Districts of Queensland. Brisbane: By Authority, 1870, p. 8.

‡ Since this Report was in type my attention has been drawn to a quotation from John Macgillivray's work, "Narrative of the Voyage of H.M.S. Rattlesnake, &c.," London, 1852, vol. ii., p. 69, showing that gold was known from the vicinity of Redscar Bay, so far back as the year 1852. Macgillivray says: "That gold exists in the western and northern portion of New Guinea has long been known; that it exists also on the south-eastern shores of that great island is equally true, as a specimen of pottery procured at Redscar Bay contained a few laminar grains of this precious metal. The clay in which the gold is imbedded was probably part of the great alluvial deposit on the banks of the rivers, the mouths of which we saw in that neighbourhood, doubtless originating in the high mountains behind, part of the Owen Stanley Range."

(*d*) Is a small quartz leader, distant about thirty feet south 10 degrees east from the shaft. The outcrop of the quartz runs east 20 degrees south. In its character the quartz is identical with that seen in the trench (*a*). A very good prospect was obtained by crushing and washing in Townsville, but only a trace of gold by assay.

(*e*) This is a continuation of the leader (*d*). Thirty feet from (*d*) the quartz is twelve inches in thickness. The character of the quartz is also the same. Between (*e*) and (*f*) very ferruginous and cavernous quartz could be seen lying on the surface. It contained a very high percentage of limonite, and yielded, on panning off in Townsville, a good prospect of gold.

(*f*) Near the summit of a small rise upon the claim is a trench, in which two reefs are seen. The hanging-wall reef (*f*) is three inches in thickness; it is separated by four feet of decomposed clayey shales from the footwall reef (*f* 2), six inches in thickness. The reefs underlie at angles varying from 75 degrees to 80 degrees, and trend west 30 degrees north. The quartz of the two reefs is identical with that in trench (*a*). No "colour" was obtained in Townsville by crushing and washing.

Quartz can be followed from (*f*) towards an old well, distant about twenty-five feet to the west. In the old well a thin leader is exposed, trending north-west. The stone differs from that of either of the two leaders in the trench (*f*), in not being so cellular, and in containing a small quantity of iron pyrites. It prospects very well.

(*h*) Is a shallow trench, showing from six to twelve inches of quartz trending north 10 degrees west.

(*i*) Six inches of quartz running east 10 degrees south.

Missing Link Claim.

Near the head of one of the tributaries of the creek upon which the Caledonian is situated is the Missing Link Claim. At the time of my visit no work was going on. A vertical shaft has been sunk on the claim to a depth of twenty feet. This had been timbered almost to the bottom. I descended the shaft, and at its foot saw a quartz reef of ten inches trending east 30 degrees south, and underlying at 70 degrees. On assaying a sample for me, Messrs. Coane and Clarke obtained merely a trace of gold. A little distance west of the shaft, and presumably on the same line of reef, is a trench showing nine inches of quartz running east and west. The stone prospects very well.

Between the trench and the shaft the outcrop of a quartz reef crosses the track in a north-westerly direction. Over the brow of the hill, to the south of the Missing Link, three or four inches of quartz (*k*) are exposed in a cutting along the side of the track. The strike is west 15 degrees north, and the underlie is 75 degrees to north 18 degrees east.

The country in the vicinity of the mines and the landing-place is covered in places with a thin coating of cement, made up of rounded pebbles of quartz cemented by an oxide of iron. I was informed that a little gold was obtained from this, but I could not verify the statement.

A few men were reported to be working for alluvial gold in the northern part of the Sudest, but I had no opportunity of visiting the claims.

MISIMA (ST. AIGNAN) ISLAND.

Prospecting operations on the Island of Misima (St. Aignan) are at present confined to the western end.

From the anchorage of the "Merrie England," off Bagoya, where the quarters of the Resident Magistrate of the Louisiade Group are situated, I was guided to Gumonina (Inkomanaina) Creek, on which a few men were engaged in working for alluvial gold.

Gumonina Creek flows in a general southerly direction, and enters the sea on the south coast of the island, somewhere between the villages of Gaibobo and Labbipai.

The first claim visited was the one about two miles above the mouth of the creek. The holder, Mr. Thomas Downey, was engaged in preparations for sluicing, and had apparently not been long at work on the claim. Being at such a comparatively short distance from the mouth of the river, and so far from what may be called the range, the alluvium was very thick. From the top of the bank to the surface of the water in the river I estimated to be about ten or twelve feet. No bottom had been reached. A dish of wash-dirt was taken from near the top of the bank, and gave a very good prospect. Another dish, taken from near the bottom of the bank, yielded a fair quantity of gold. The wash-dirt contained fragments of quartz and slaty rock.

A short distance up the creek, clayey slates can be seen in the banks to dip at high angles to the east.

The next claim, held by Mr. J. Blanchfield, is situated much further up Gumonina Creek than that of Mr. Downey. Here the creek flows in a narrow valley with steep walls of schistose rock. The ground is sluiced by means of a covered tail race. The wash-dirt is not of so great a thickness as that lower down the creek. The bottom, exposed where the ground has been turned over, is a quartzose graphitic schist [52].

A little higher up the creek was a claim held by two men, whose names I did not learn. No work was going on.

Judging by the number of abandoned workings, Gumonina Creek must have, at one time, given employment to a considerable body of men. There are now only about half-a-dozen at work. Their efforts certainly deserve to be crowned with greater success.

A few men were at work on Ana (St. Patrick's) Creek, which flows into the sea on the north of the island, but I did not visit the place. Two small bags of wash-dirt, procured by the Hon. M. H. Moreton, at one time Resident Magistrate of the district, were given to me, and on panning-off in Townsville a very good prospect resulted, considering the small quantity of dirt operated on. An unusually large percentage of the stones in the dirt were of quartz (very often ferruginous), pointing to the presence of reefs in the drainage area of Ana Creek. Some of these reefs may be, and in all probability are, concealed by the thick horizontal beds of coral limestone (portions of a raised coral reef) which cover a large part of Misima.

VANAPA RIVER.

Several bags of wash-dirt were collected by the Administrator's party on the Vanapa River, and Mr. W. H. Rands, to whom an examination of the specimens was entrusted, detected small quantities of gold in several of them, by panning off.

Whilst

Whilst stating that "the presence of gold in these alluvial deposits is of great interest as showing that the region is to some extent auriferous," Mr. Rands expressed the opinion that "there is nothing to warrant miners from any distance going to prospect this district in its present unsettled state, as the small quantity of gold in the specimens may have come from small leaders in the schists."*

DUAU (NORMANBY).

Gold associated with cinnabar has been discovered by Mr. William Nettle near the south-east end of the island, and specimens of it are now in the Museum of the Geological Survey. As to the exact locality of the discovery Mr. Nettle gave no further particulars than are contained in the following extract from his letter:—"Our party came across several large reefs, one about 20 feet wide on the surface, but no gold visible to the eye, or by dollying. The specimen sent was found close to the reef, in slate formation . . . . ."

MEKEO (SAINT JOSEPH) DISTRICT.

Colours of gold have been reported from the Mekeo district.

A collection of specimens, acquired by the Royal Geographical Society of Australasia's Expedition to the Kovio Range, was placed in my hands for examination. Along with the collection was a memorandum from Mr. Wm. Nettle, the Prospector attached to the Expedition. From his Notes, coupled with Journal published by the Leader, Mr. Geo. Belford, it is possible to deduce the following facts:—

In all the gullies in which there occurred "slate, ironstone, and quartz" colours of gold were obtained. [In the collection which passed through my hands there were no slate rocks.]

When the flanks of the mountains were reached volcanic rocks and grits and basalts prevailed, and no gold was reported.

Among the specimens was a bag of washdirt, collected from the bed of what the leader named No. 4, or Nameless River, and reputed to contain gold. The washdirt received in Townsville was found to be made up of a large percentage of magnetic oxide of iron, with particles of olivine (?) and felspar. In the Report quoted above the opinion was expressed that the sand was derived from the denudation of some volcanic rock.

YIELD OF GOLD FROM NEW GUINEA.

The following is a return showing the quantity of gold reported from New Guinea up to the end of the year 1891:—

RETURN showing QUANTITY of GOLD REPORTED INWARDS from NEW GUINEA during Years 1888, 1889, 1890, and 1891.

Dates.	1888.		1889.		1890.		1891.	
	Yield.	Value.	Yield.	Value.	Yield.	Value.	Yield.	Value.
	ozs.	£	ozs.	£	ozs.	£	ozs.	£
Quarter ending March	Nil	Nil	1,129	4,148	1,264	4,430	350	1,225
Quarter ending June	Nil	Nil	1,167	4,340	475	1,520	337	1,196
Quarter ending September	156	624	988	3,814	470	1,752	222	830
Quarter ending December	1,398	5,275	742	3,676	380	1,230	320	1,250
Total	1,554	5,899	4,026	14,978	1,589	8,932	1,229	4,501

(Signed) H. BURKITT, Sub-Collector.

H. M. Customs, Cooktown. ... ...

IRON.

Iron pyrites, the sulphide of iron, is widely distributed throughout the rocks of British New Guinea. Quantities of it are found in the crystalline schists, and also in the quartz reefs, associated with the gold. Large boulders of it occur in the washdirt in the island of Misima.

In the sandy calcareous beds in the vicinity of Port Moresby, curious masses of compacted cubes of iron pyrites, of a rudely spherical form, are met with. These can be easily collected from the weathered surfaces of the rocks. Somewhat similar nodules were met with in the washdirt in Ana (St. Patrick's) Creek, Misima. When a nodule is broken open it is found that there is a gradual passage from the sulphide to the oxide of iron. Quartz is contained in some of the interstices between the cubes of pyrites.

From the Fly River D'Albertis obtained iron pyrites in "dark liver-coloured masses showing radiate structure when broken open"† . . . This yielded a trace of gold. Limonite "in the form of nodules with a concentric structure" was also obtained by D'Albertis from the Fly River.

Some of the cellular limonite from the quartz-reefing district of Tagula contains gold visible to the unaided eye.

The magnetic oxide of iron is common throughout those areas in which there is any development of volcanic rocks.

None of the iron ores yet discovered in the Possession appear to be of any commercial importance.

SULPHUR.

Native sulphur is known to occur in two of the islands of the D'Entrecasteaux Group, viz.:—Moratau (Fergusson) and the small island of Dobu (Goulvain). On the former, in the vicinity of Seymour Bay, large areas exist, and have been described by the Administrator. On the latter, deposition of flowers of sulphur is taking place at the present time along the fissures which traverse a portion of the beach along the north coast. The quantity deposited is not large.

GRAPHITE.

* Rands, W. H., Report on Geological Specimens, &c., Ann. Rept., British New Guinea, 1888-89. Brisbane: By authority, 1890.

† Prof. A. Liversidge. Preliminary Notes on some Rocks and Minerals from New Guinea. Appendix to Minerals New South Wales. London, 1888. p. 249.

GRAPHITE.

The presence of graphite or plumbago has been demonstrated over nearly the whole of the known portion of the Possession, but always as an accessory constituent of the schists; in some cases it occurs in such a quantity as to give a distinctive character to the rocks. In the most graphitic of the schists, although the quantity is proportionally large, to remove the impurities (chiefly quartz) by washing or other means, would be too costly to be remunerative.

LIGNITE.

From Yaru (Yarrn) Island, at the mouth of the Oriomo (Tate) River, latitude 9 degrees 55 minutes S., longitude 143 degrees 15 minutes, E. D'Albertis obtained specimens of lignite. The lignite has been examined by Professor A. Liversidge, from whose Report the following is taken:—

"Of a brown colour, with lamellar structure where weathered; somewhat like dysodile; exhibits a woody structure; gives a brown streak or powder; breaks with a well-marked conchoidal fracture, yielding a black lustrous surface; burns with difficulty, without flame; emits but little smell, and leaves a dark grey ash, very bulky, and resembling wood ash. It is not sectile, but flies off in powder before the knife."*

The Administrator's party, in January, 1890, discovered a bed of lignite in the bank of the Fly River, about 30 miles above the Palmer Junction (latitude 5 degrees 35 minutes south, longitude 141 degrees 35 minutes east.) The locality is thus described:—"At about half a mile above our camp there is a spot on the right side of the river where the bank is about 35 feet high, the upper portion consisting of sandstone; then comes a seam of lignite 6 inches thick, then 10 feet of sandstone to the water's edge. Specimens of this lignite, which seems to be useless for all practical purposes, were obtained, also of the sandstone below it. At some places the forms of trees were distinctly distinguishable in it."† A specimen of this lignite yielded an ash of a yellowish-grey colour, and somewhat bulky.

On the banks of the Strickland River, an important tributary of the Fly, a thick seam of lignite, of no commercial value, was discovered by the Royal Geographical Society of Australasia's Expedition in 1885.‡

MERCURY.

Cinnabar (sulphide of mercury) has been reported from only two places in the Possession—viz. Merani, in Cloudy Bay, and from the Island of Duau (Normanby).

The history of the specimen of cinnabar, discovered by the Administrator's party at the Village of Merani, "could not be obtained."§ In November of the year 1890, Mr. Wm. Nettle presented to the Queensland Geological Survey Collection, specimens of alluvial gold with cinnabar, which were stated to have been obtained from an unmentioned locality on Duau.

When in New Guinea, I had an opportunity of conferring with Mr. Nettle, but was unable to glean anything further as to the portion of Duau from which the specimens came.

The cinnabar occurred in the form of small partially waterworn masses of a bright red colour when powdered; associated with this, was gold and a small quantity of magnetite. This actual discovery of mercury, on the Island of Duau, is of great interest.

As described on a previous page, the Islands of Duau and Moratau are remarkable on account of the very large area of hot springs, sulphur banks, and fumeroles.

Having in mind the discovery of cinnabar and gold in the deposit round some of the solfataras at present forming in the Lake Country of California, I caused an analysis of the material forming round the fumerole, on the small Island of Dobu, to be made. The material was found by Messrs. Stokes and Hall, in whose laboratory the analysis was made, to have the following composition:—

Silica	87·16
Alumina	2·20
Iron Protoxide	2·66
Manganese	trace
Lime	trace
Potash } Soda }	0·21
Loss on ignition	7·87
	100·10

The analysis, in addition, showed a trace of free sulphur.

* Liversidge, Prof. A. "Notes on some Rocks and Minerals from New Guinea, etc." Appendix to Minerals of New South Wales, Trübner, London, 1888, p. 250.

† Despatch 1, 1890, par. 25.

‡ Wilkinson, C.S., F.G.S., "Report on Geological Specimens from New Guinea," Trans. and Proceed. Royal Geog. Soc. Austr., vols. iii and iv., p. 205.

§ Despatch 93 1889, p. 24.

APPENDIX A.

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A. GIBB MAITLAND,

Assistant Geologist,

Geological Survey of Queensland.

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Nº 1

GEOLOGICAL SKETCH MAP

to accompany Report on

GEOLOGICAL OBSERVATIONS

IN

BRITISH · NEW · GUINEA

BY

A. GIBB MAITLAND, F.G.S.,

Assistant Geologist,

GEOLOGICAL SURVEY OF QUEENSLAND.

1892

INDEX TO COLOURS

Recent Superficial Deposits	
Raised Coral Reefs	C
Kevori Grits	A
Port Moresby Beds (Tertiary)	K
Boioro Limestones (Age undetermined)	M
Slates, Schists &c. (Age undetermined)	S
Basalt and all other Volcanic Rocks	B
Diorite and all other Basic Plutonic Rocks	D

Scale 10 Miles to an Inch

0 5 0 10 20 30 40

PRINTED AT THE GOVT. ENGRAVING & LITHOGRAPHIC OFFICE BRISBANE, QUEENSLAND.

GEOLOGICAL BOUNDARIES APPROXIMATE

NOTE:-A detailed survey is yet required to render the topography of the map accurate.

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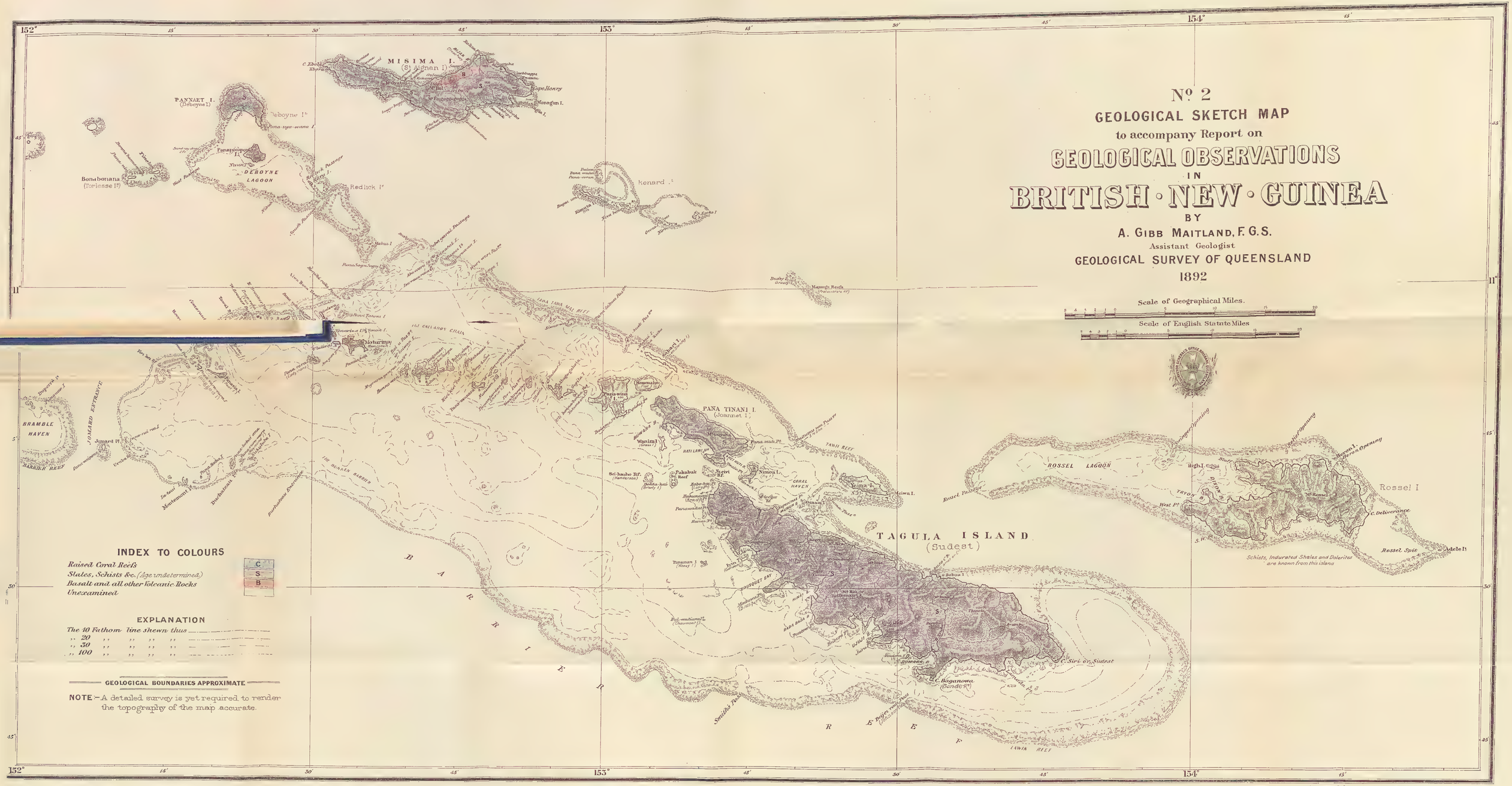
No 2
GEOLOGICAL SKETCH MAP
to accompany Report on
GEOLOGICAL OBSERVATIONS
IN
BRITISH · NEW · GUINEA
BY
A. GIBB MAITLAND, F.G.S.
Assistant Geologist
GEOLOGICAL SURVEY OF QUEENSLAND
1892
Scale of Geographical Miles.
Scale of English Statute Miles
INDEX TO COLOURS
Raised Coral Reefs
Slates, Schists &c. (Age undetermined)
Basalt and all other Volcanic Rocks
Unexamined
C
S
B
EXPLANATION
The 10 Fathom line shewn thus
,, 20 ,, ,, ,, ,,
,, 30 ,, ,, ,, ,,
,, 100 ,, ,, ,, ,,
GEOLOGICAL BOUNDARIES APPROXIMATE
NOTE—A detailed survey is yet required to render the topography of the map accurate.
MISIMA I.
(St Aignan I.)
PANNAET I.
(Deboyne I.)
Deboyne I.
DEBOYNE LAGOON
Bonabonana
(Torlesse I.)
Redlick I.
Kenard I.
PANA TINANI I.
(Joannet I.)
TAGULA ISLAND
(Sudest)
ROSSEL LAGOON
Rossel I
Mt Rossel
Rossel Spit
Adele I.
C. Deliverance
C. Sir Or. Sudest
C. Baganoma
(Sudest)
BRAMBLE HAVEN
JOMARD ENTRANCE
Jomard I.
Moturina
Nimoa I.
Wanimi
Pana-wina I.
Hannaina
Sei-hauhe Rf.
Pahabuk
Nivvi Rf.
Yelina I.
Mewa I.
Tawin I.
Panaman I.
Mt Riu
Mt Hinuhinu
Mt Hiu
Mt Dagabo
Mt Bwaibwai
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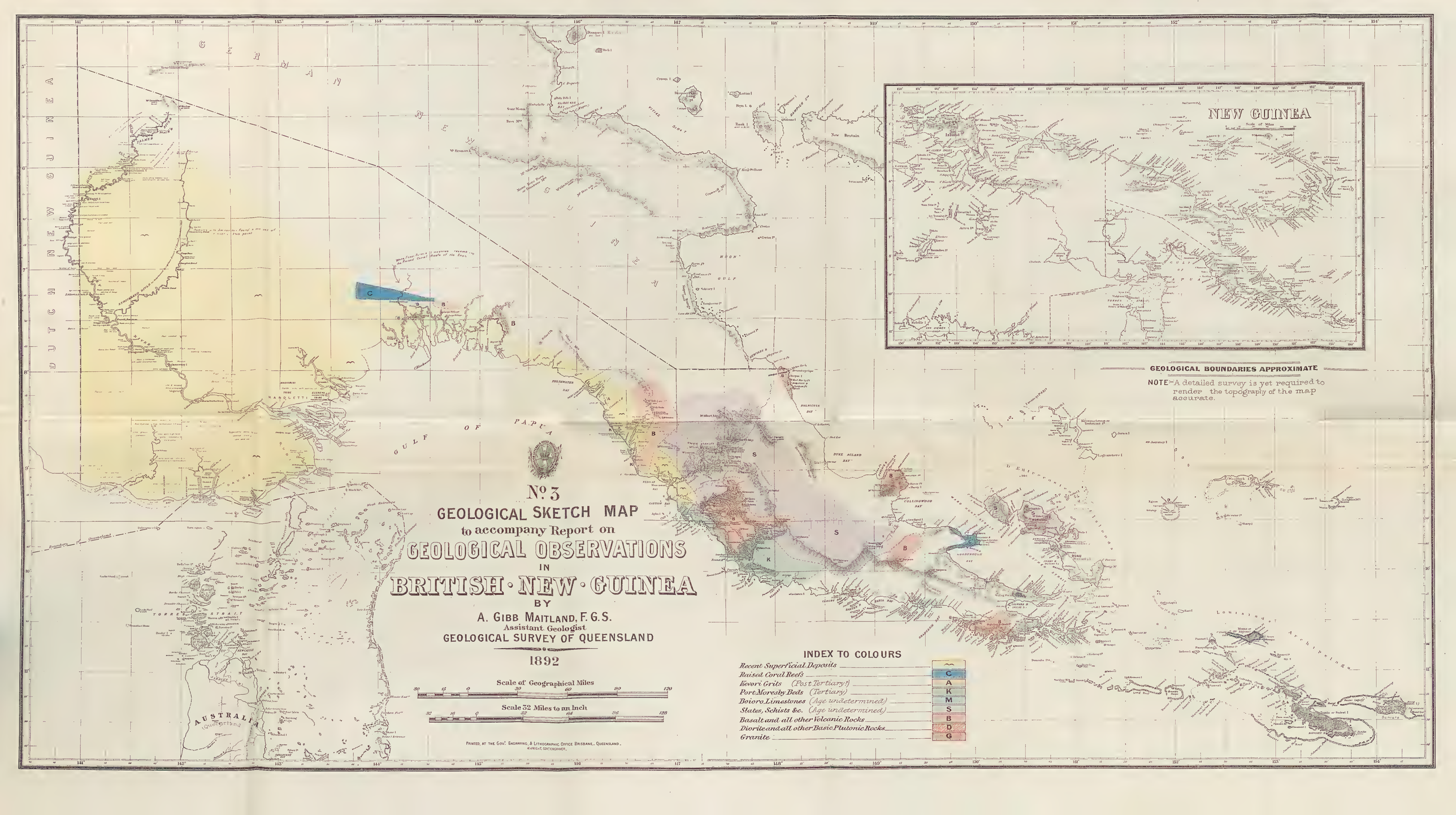
No. 3
GEOLOGICAL SKETCH MAP
to accompany Report on
GEOLOGICAL OBSERVATIONS
IN
BRITISH · NEW · GUINEA
BY
A. GIBB MAITLAND, F.G.S.
Assistant Geologist
GEOLOGICAL SURVEY OF QUEENSLAND
1892
Scale of Geographical Miles
30 15 0 30 60 90 120
Scale 32 Miles to an Inch
32 16 0 32 64 96 128
INDEX TO COLOURS
Recent Superficial Deposits
Raised Coral Reefs C
Kevori Grits (Post Tertiary?) A
Port Moresby Beds (Tertiary) K
Boioro Limestones (Age undetermined) M
Slates, Schists &c. (Age undetermined) S
Basalt and all other Volcanic Rocks B
Diorite and all other Basic Plutonic Rocks D
Granite G
GEOLOGICAL BOUNDARIES APPROXIMATE
NOTE—A detailed survey is yet required to render the topography of the map accurate.
NEW GUINEA
Scale of Miles
GERMAN NEW GUINEA
DUTCH NEW GUINEA
GULF OF PAPUA
AUSTRALIA
(Queensland)
TORRES STRAIT
SOLOMON ARCHIPELAGO
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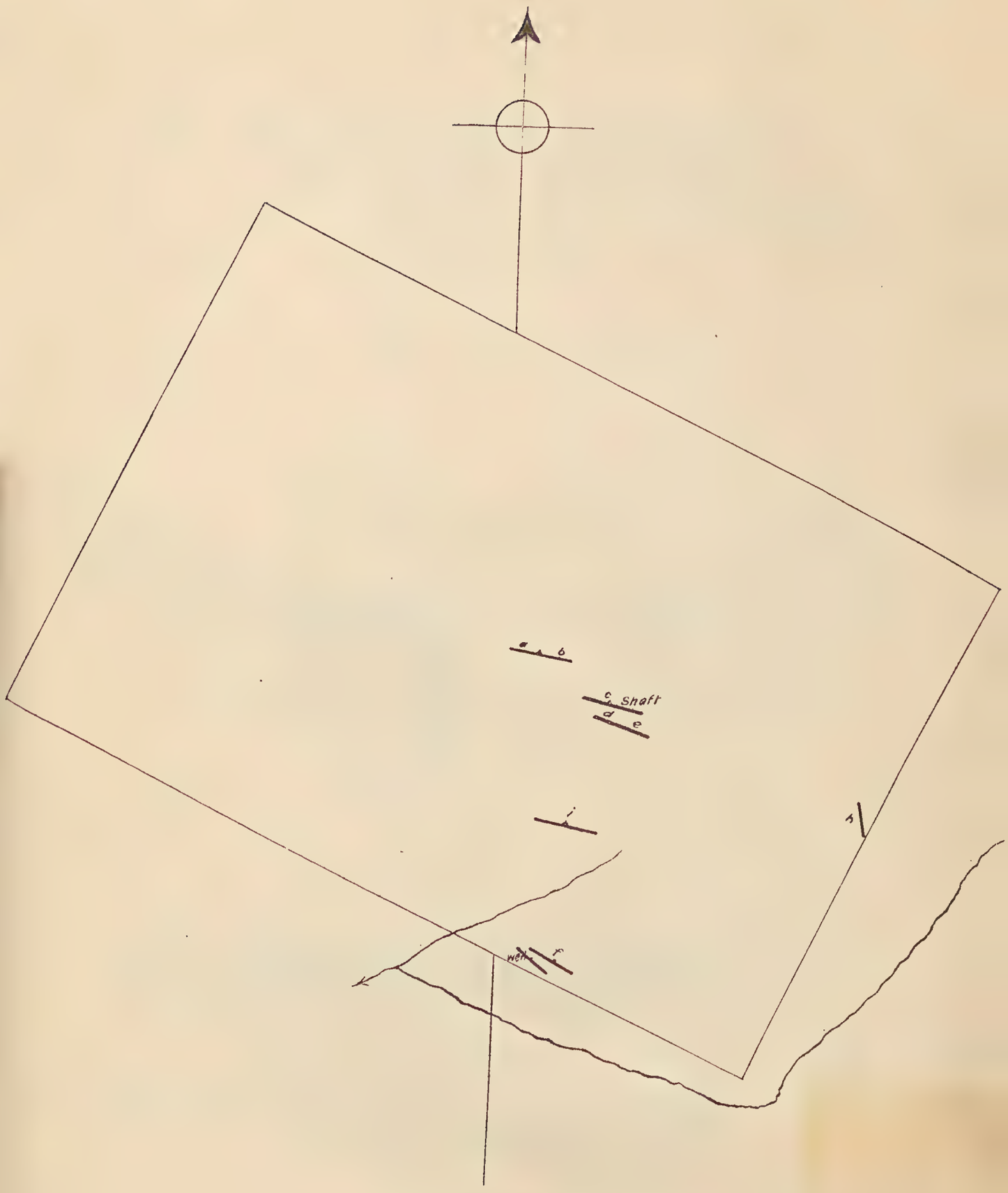

SKETCH PLAN

OF THE

CALEDONIAN REEFS

NORTH EAST END OF TAGULA (SUDEST) ISLAND

BRITISH NEW GUINEA

Scale 300 feet per inch.

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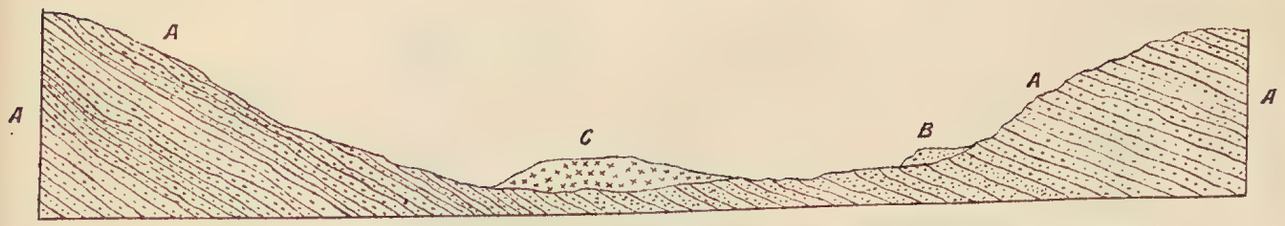
Figure 1.

SECTION ACROSS THE MAIVA HILLS

~ *Alluvial flats.* *A. Kevori Grits.* *K. Limestone (Port Moresby Beds)*

Figure 2.

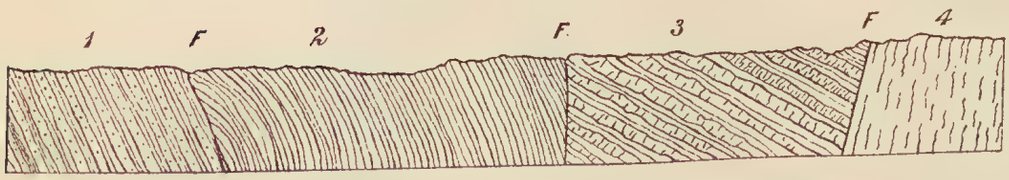


SECTION AT THE SOUTH WEST END OF RORO (*YULE ISLAND*)

A. Calcareous Sandstones. *B. Raised gravelly Beach.*

C. Basaltic Lava.

Figure 3.



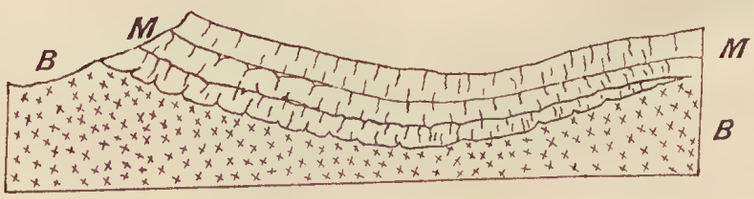
SECTION AT DELENA (*HALL SOUND*)

1. Buffshale, Sandstone & Conglomerate. *2. Fossiliferous Clayshale.*

3. Thinlybedded Limestones. *4. Massive Coralline Limestone.*

F.F. Faults. 1.2.3.4. Port Moresby Beds.

Figure 4.



SECTION IN KARAGA BAY ROGEIA (*HEATH*) ISLAND

M. Limestone. *B. Dolerite.*

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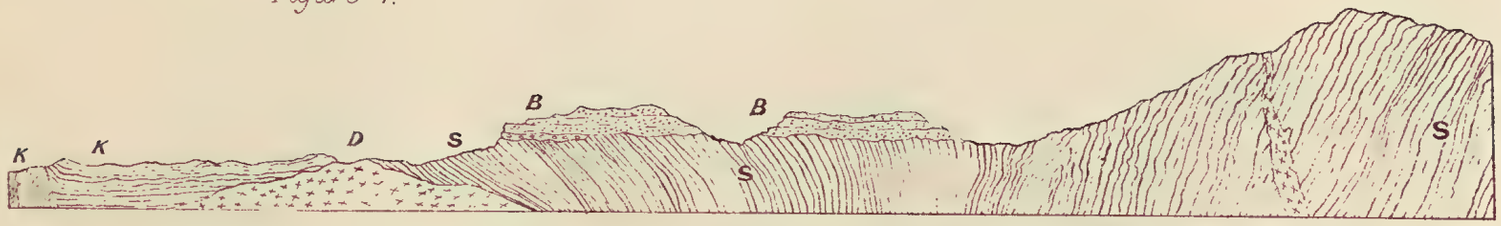
Figure 1.



GENERALISED SECTION FROM PORT MORESBY TO THE MAIN RANGE

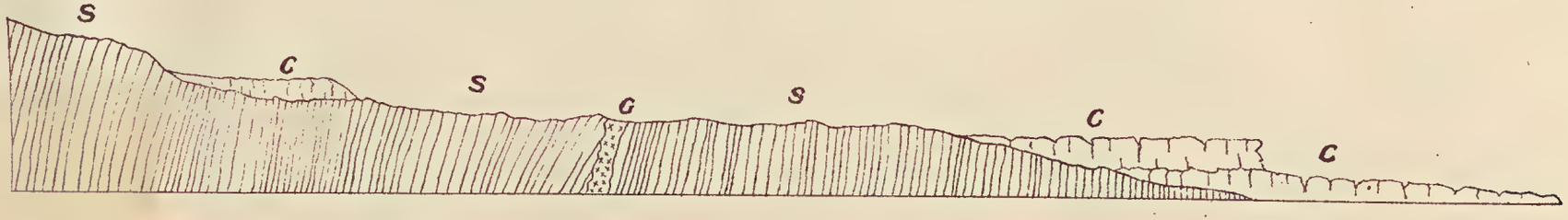
K. Port Moresby Beds. D. Coarse Diorite. S. Slates, Schists &c. B. Basaltic Ashes &c.

Figure 2.

SECTION IN WAIERA CREEK

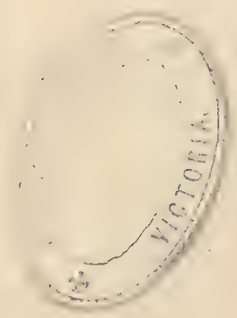
B. Dolerite. M. Limestone.

Figure 3.



SECTION IN GUMONINA CREEK MISIMA (*ST AIGNAN*) ISLAND

S. Schists. G. Granite Dyke. C. Coral Limestone.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1892.

QUEENSLAND.

OLSEN'S AND JOHANNSEN'S CAVES, NEAR ROCKHAMPTON.

(REPORT ON, BY WILLIAM H. RANDS, ASSISTANT GOVERNMENT GEOLOGIST.)
WITH MAP AND PLATE.

Presented to both Houses of Parliament by Command.

TO THE HONOURABLE THE MINISTER FOR MINES.

Geological Survey Office, Elizabeth Street,
Brisbane, 5th August, 1892.

SIR,—I have the honour to hand you herewith Mr. Rands' Report on Olsen's and Johannsen's Caves, together with Map and Plate.

I have, &c.,
ROBERT L. JACK,
Government Geologist.

Olsen's and Johannsen's Caves are situated in ridges of limestone which form a prominent feature in the landscape in the neighbourhood of Mount Etna. Their positions are shown on a local sketch map attached to this Report.

The limestone ridges stand boldly out of the surrounding country to a height of about 160 feet. The sides of the ridges are almost entirely covered with a dense vine scrub, except where, every here and there, large bluffs of grey limestone stand out in picturesque relief. The summits of the ridges are rugged and bare.

The limestone is very highly weathered, into the form of small pinnacles or spires, which are deeply fluted, the edges being almost as sharp as knives. The weathered surface is generally grey, but a clean fracture shows the limestone to be of a mottled reddish-brown and grey colour and highly crystalline.

The only fossils in this limestone which have been identified are two species of corals, *Heliolites porosa*, Goldfuss, and *Favosites gothlandica*, Edwards and Haime, that I found in one of Johannsen's Caves, which I named the "Coral Cave." These corals are well preserved, and are identical with forms found in the Burdekin Beds—Middle Devonian—at Broken River, Burdekin Downs, and Reid's Gap, near Townsville. The limestone, may, therefore, pending the production of further evidence, be classed with the Middle Devonian or Burdekin Beds.

The limestone is too crystalline, and too much altered, to lead one to expect to find fossils well preserved; in fact, I could find none at all visible to the naked eye, but, on slicing thin sections of the less altered portions for examination under the microscope, I could trace the outline of corals of the *Favosites* tpye, the interiors of which were completely filled up with calcite.

These ridges of limestone must have formed coral reefs of some considerable thickness in the Devonian sea. They are now surrounded by rocks which were probably deposited in Permo-Carboniferous times; for in the limestone close to the "Caves Hotel," about two miles south-west of Olsen's Caves, *Stenopora* and Rugose corals, much resembling Permo-Carboniferous forms, occur in large numbers. These corals have not, however, been finally determined.

The caves have been formed by the prolonged abstraction of the lime in a state of solution, by water containing carbonic anhydride in solution; the water obtaining entrance through fissures and cracks in the limestone, widening these to the dimensions of caves, and issuing again on the sides of the ridges near their bases. In many cases the roof of a cavern has collapsed, leaving a deep natural shaft as the only entrance.

The caves, as a whole, are by no means rich in ornamentation in the form of stalactites and stalagmites, although some beautiful ones occur here and there. I regret to say that in many cases the ornaments have been wantonly destroyed by visitors.

The walls of the caves are covered by a secondary deposit of lime which takes peculiar forms, sometimes resembling large masses of coral. The strange forms, too, produced by the dissolving away of the limestone rock, add greatly to the weird appearance of the caves. The floors are in some places covered with a layer of an agglutinate which has been formed by the cementing together of particles of limestone by lime. This agglutinate is full of Wallaby and Bat bones, &c., and also of shells of species of *Helix* and other recent land molluses. This agglutinate is covered to varying depths with bat guano, to which I shall refer later on in this Report. The caves have become the home of many thousands, if not millions, of bats.

OLSEN'S CAVES.

These are situated about fifteen miles north-west 5 degrees west of Rockhampton, and about north 40 degrees east of the "Caves Hotel," on the Rockhampton and Yaamba road.

Travelling along the road between the hotel and the caves, the country is seen to consist of slates, with the limestone containing *Stenopora*, already alluded to, and a small deposit of magnetic iron ore.

The entrance to the main caves is near the foot of the ridge on its southerly fall, and is one of the prettiest sights in connection with the caves. It is formed by a cleft in the rock, about 90 feet high and about 60 feet in breadth. The rocky sides of the entrance are covered with thick creepers and scrub trees, which jut out, having their roots wedged in the cracks of the rock, or bound to overhanging ledges; while long trailing vines and roots of fig-trees hang down in graceful curves. Huge boulders of limestone, covered with creepers and ferns, are strewn about the floor.

At the end of this natural cutting the dark entrances to the caves are visible, while high above it the pinnacles of limestone stand out in bold relief. A photograph of the entrance, taken by Mr. H. Goode, Rockhampton, and kindly lent by him for reproduction in this Report, is attached. It has been reproduced in collotype by Mr. E. H. Murray, Brisbane.

A great part of the ridge seems to be a regular network of caves, and there are undoubtedly many not yet discovered, to which access would be difficult.

The Cathedral Cave.—This is the finest of all the caves. It is situated about two chains north-west of the main entrance, and is approached by more or less tortuous passages and ladder-ways. It is circular in form, and about 35 feet in diameter. The height of the roof must be at least 70 feet. At the south-eastern side there is a passage or aisle 55 feet in length. There is a large stalagmite called the "Font," about 5 feet in height, in the centre of the floor; and on the northern side there is a ledge of rock called the "Pulpit." Any stalactites that may be hanging from the roof are hidden in darkness. The floor of the cave is covered with bat guano. A hole—6 feet in depth—was sunk into it, but did not reach the bottom. There would be, therefore, at least 9,000 cubic feet of this guano in the cave.

West of the Cathedral Cave, and at a slightly higher level, a zig-zag passage runs right through the ridge. Near the northern end of this passage is what is known as *The Belfry Cave*, so named on account of the long roots of fig trees which hang down like ropes from the roof. The cave is 170 feet in length by 85 feet in breadth. Its floor is covered with guano to varying depths, through which limestone rocks rise up.

About 300 yards east of the zig-zag passage, another passage known as *The Arcade*, about four chains in length, runs through the hill. A few fine stalactites occur in this passage, especially one like a broken column.

Near the northern end of the Arcade passage is *The Strong Room Cave*. This cave is 35 feet below the level of the passage, and is approached by a shaft-like entrance. It is 108 feet in height and 85 feet in breadth. A hole was drilled to a depth of 15 feet in the guano on the floor without reaching the bottom. Another cave—*The Deep Vault Cave*—occurs near the southern end of the passage. The access to this cave is very difficult. The guano from this cave would have to be raised a height of from 50 to 60 feet.

The Shaft Cave is 150 yards south 30 deg. west of the main entrance to the caves. The only entrance to it is by a natural shaft 40 feet in depth. The cave is 24 feet by 30 feet, and the floor is covered with guano and bones of marsupials. Beautiful stalactites occur in small caverns near the surface.

Some other caves occur in a scrub in Olsen's Selection about ten chains south of the main caves. From one of these 100 tons of guano were taken away.

JOHANNSEN'S CAVES

Are situated in another mass of limestone about a mile and a-half west of Olsen's Caves and about 40 chains east to a little north of east of Mount Etna.

On its western slope Mount Etna is composed of hard, siliceous slates, dipping south 40 degrees east at 45 degrees. The eastern slope is of limestone, similar to that in which the caves occur.

About two-thirds of a mile along the road to these caves from the main road, and in a direction east 39 degrees south of Mount Etna, there is a hill composed of impure serpentine and serpentinous schist, on which I picked up some pieces of asbestus with a fibre of over six inches in length. The surrounding country is of a siliceous slate, similar to that on Mount Etna.

The Fountain Cave is situated north 51 degrees east of Mount Etna, and distant from it about fifty chains. The cave is 210 feet in length and 50 feet below the surface, and is entered through a natural shaft down which we descended by the aid of a ladder. A flat stalagmite, resembling an ornamental fountain, has given the name to this cave. The stalactites are more numerous in this cave than in the others. The floor is entirely covered with guano.

The Main or *Dyke Cave* is approached by a winding corkscrew-shaped passage. To the left of this passage, on entering the cave, the most beautiful stalagmite occurs that I saw in any of the caves. It has unfortunately been spoilt by the breaking off of two of the pinnacles. All round the side of it the lime has assumed a coral-like growth. At the end of a passage seventy feet north of the stalagmite a dyke of basalt occurs, running through the limestone in a direction east 20 degrees north. The dyke is from eight to twelve feet in width. The limestone near the basalt is highly crystalline.

After travelling by passages in a westerly direction, another cave called *The Cathedral Cave* is reached, which consists of a number of passages or aisles.

The Coral or *Crystal Cave* is east 5 degrees north of Mount Etna, and south 10 degrees east of the Dyke Cave. It is situated just beneath the highest point of the limestone ridge known as the Crystal Peak. The cave is situated high up in the range, and there would be some difficulty in making a road to it through the scrub to take away the guano, of which there must be a great number of tons in the two principal chambers, as in one there is at least a thickness of fifteen feet of it. I named this cave the Coral Cave, as it was here I found the corals *Favosites gothlandica* and *Heliolites porosa*, referred to at the beginning of this Report. Another cave is situated about 150 yards south of the above. The size of this cave could not well be ascertained, as the passages were filled up with guano.

ECONOMIC VALUE OF THE BAT GUANO.

Vast quantities of guano are annually used for manuring purposes. Peru alone, between the years 1869 and 1877, exported no less than 3,532,882 tons, or an annual average of 392,542½ tons. England and the Colonies imported in the year 1876, 130,598 tons; and in 1877, 100,954 tons. The average value of this guano was about £12 per ton.

In addition to the natural guano, large quantities are now annually manufactured from waste animal-products, such as bones, &c.

Bat guano has been obtained in large quantities, in caverns, in certain parts of France, the Pyrenees, Italy, New Zealand, and North America. This guano generally contains a very large proportion of water in its composition, often as much as 60 per cent. It contains, as a rule, about 5 per cent. of phosphates and from 3 to 7 per cent. of ammonia.

The ingredients in guano that are especially useful for manure are the ammonia and the phosphates.

The following analyses show the percentages of those substances in various guanos:—

	Ammonia.	Phosphates.
Peru (average of 13 samples)	17·41	24·17
Patagonia (average of 14 samples)	2·54	44·60
Bolivia (average of 14 samples)	4·00	42·00
Ichaloe (average of 11 samples)	7·30	30·00

Professor Simmonds, in his book on "Waste Products and Undeveloped Substances," gives the following percentages:—

	Ammonia.	Phosphates.
Norwegian Guano	10·52	27·00
Chili and Peru	9·24	25·00

In Peru the guano is now sold on analysis by the unit. Every unit per cent. of ammonia is set down as worth 19s. 2d. per ton, and every unit per cent. of the phosphates at 2s. 3½d. per ton.

For comparison with the above, I give some Analyses from the Rockhampton Caves:—

	OLSEN'S CAVES.					JOHANNSEN'S CAVES.
Analysed by	1. J. Cosmo Newberry.	2. Thomason and Stainer.	3. Thomason.	4. R. Mar.	5. R. Mar.	R. Mar.
Phosphates	53·79	29·15	6·30	18·45	16·65	44·05
Ammonia	1·903	9·50	1·89	0·0254	0·501	0·127
Water	19·80	23·60	17·12	...	24·80	11·25
Organic Matter	20·60	26·45	10·88	...	38·61	14·76
Other Constituents	...	...	59·71	...	...	...
Carbonate of Calcium... ...	...	...	...	...	16 23	22·85
Sulphate of Calcium	...	...	...	...	1·81	6·95
Alkalis	...	...	...	...	1·90	0·12

These Analyses give an average of 28 per cent. of phosphates and 2·33 per cent. of ammonia, which, by the unit system above alluded to, would give £5 10s. as the value of the guano per ton.

Mr. Peter McLean, Under Secretary for the Department of Agriculture, recently visited Johannsen's Caves, and in the Annual Report of the Department for the year 1891-92* gives the following Analyses, by Mr. Robert Mar, Government Analyst, of five samples of the guano collected by himself from different parts, from the surface to a depth of 8 feet:—

	No. 1.	No. 2.	No. 3.	No. 4.	No. 5.
Moisture	12·20	15 45	16·90	11·35	18·25
Volatile Matter	18·30	17·15	16·85	20·20	23·75
Phosphates	35·40	42·00	34·40	32·95	27·85
Lime	6·94	4·81	8·11	5·45	6·10
Sulphuric Acid	6·66	5·50	5·44	11·22	9 04
Alkalis	2·50	3·09	5·12	5·33	3·51
Sand	18·00	12·00	13·18	13 50	11·50
	100 00	100·00	100 00	100·00	100·00
Ammonia	Trace.	Trace.	Trace.	Trace.	Trace.

It will be noticed in all the above Analyses that, with one exception, the percentage of ammonia is very low. The appearance of the guano, when fresh, is that of a deep chocolate soil; and when it has been lying for some time, it has a dirty or brownish grey colour.

There is undoubtedly in the aggregate a large quantity of this bat guano in the caves. The caves, however, extend over so great an area, and some of them are so difficult of access, that the cost of getting the guano would be very heavy indeed. Roads would have to be made through the scrub to each cave, and in every case fresh openings to the caves would have to be made in order to get at the guano.

The distance to the nearest water carriage, from where it could be conveyed in punts to Rockhampton, is about seven miles.

WILLIAM H. RANDS.

* Brisbane; by Authority; 1892.

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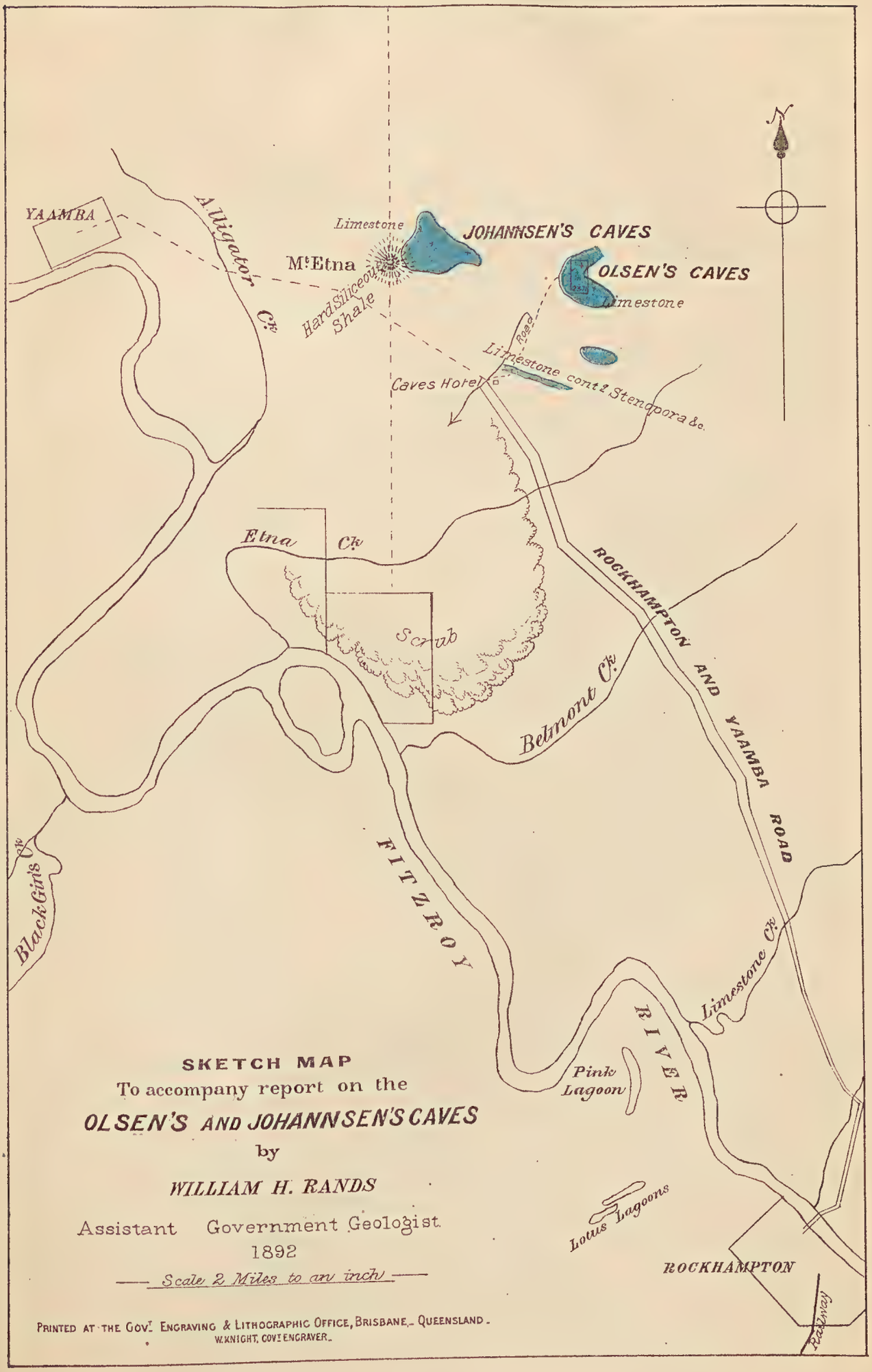
MAIN ENTRANCE TO OLSEN'S CAVES.

Geological Survey of Queensland



SKETCH MAP

To accompany report on the

OLSEN'S AND JOHANNSEN'S CAVES

by

WILLIAM H. RANDS

Assistant Government Geologist

1892

Scale 2 Miles to an inch

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